MARCH, 1949
VOL. 4, NO. 3

PETROLEUM PROCESSING

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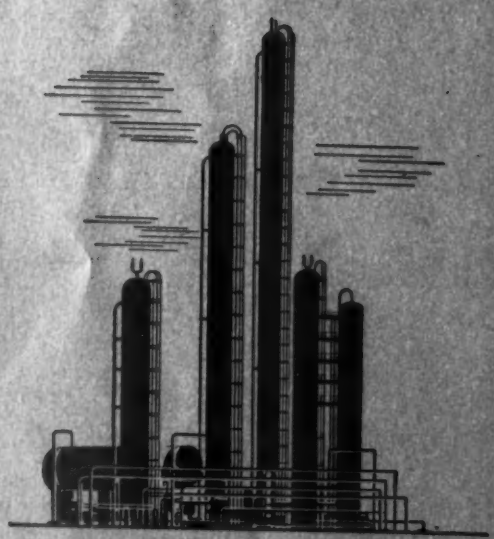
DETROIT

Illinois refiner stops vapor losses in six gasoline blending tanks with vapor-balancing unit (pg. 249)



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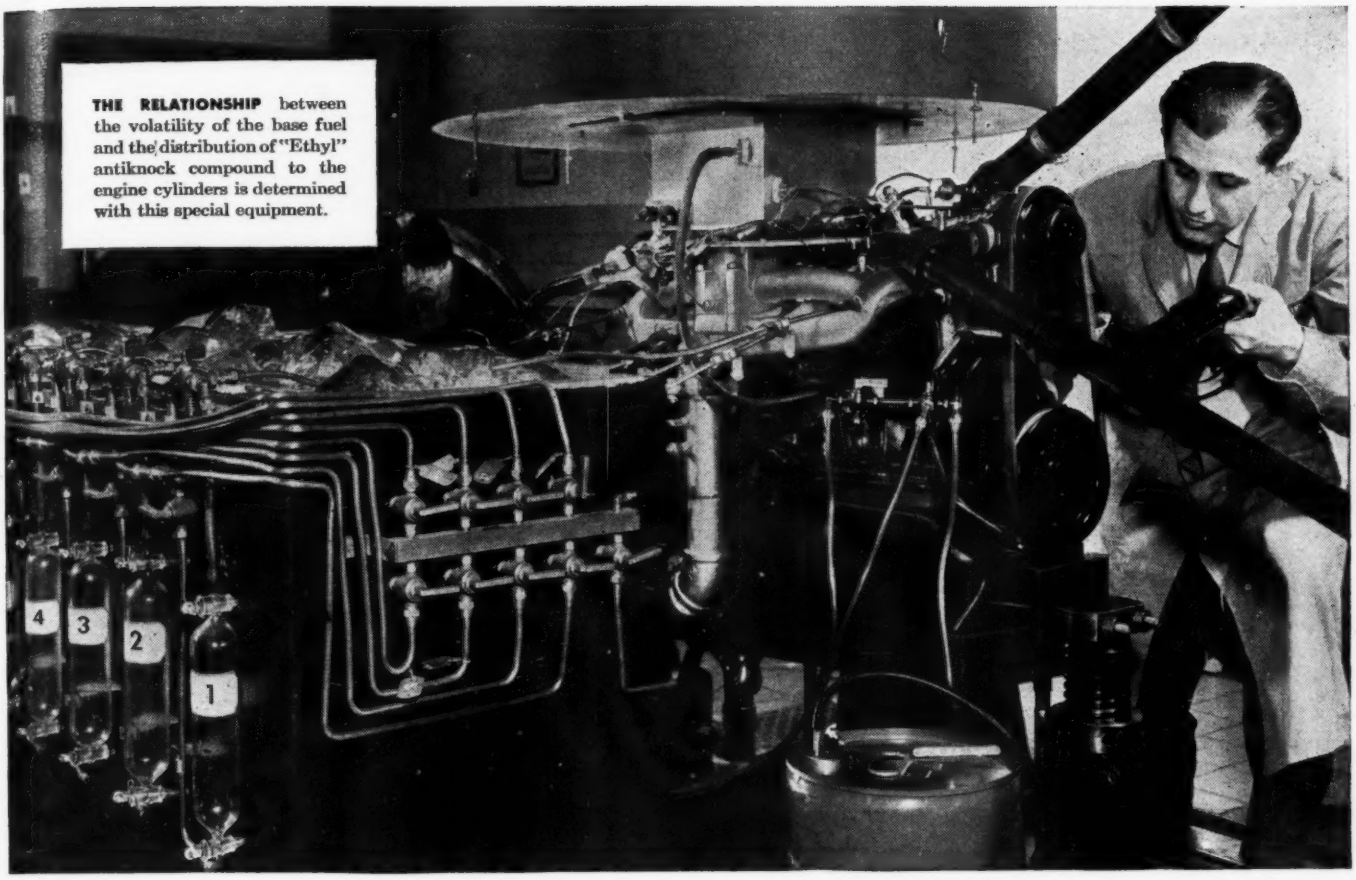

THE RELATIONSHIP between the volatility of the base fuel and the distribution of "Ethyl" antiknock compound to the engine cylinders is determined with this special equipment.

REAPPRAISING FUEL VOLATILITY

THERE are some refiners who have an excess of high-volatility stocks of good antiknock quality. There are others who, because of the use of new refining processes, may find it advantageous to produce quantities of high-antiknock stocks of relatively low volatility. The ability of such refiners to blend these stocks into motor gasoline might result in greater flexibility and economy of refinery operation.

The needs of automotive transportation are served best by the greatest possible flexibility in the refining of petroleum products. It is desirable, therefore, that automotive designers make every effort to minimize the sensitivity of engines to fuel volatility.

The problem of using gasolines that contain high-boiling fractions, in particular, presents a challenge to the automotive engineer, because it is not desirable that distribution to the cylinders be obtained through excessive heating of the intake manifold. Such heating not only reduces volumetric efficiency and power output, but tends to depreciate the antiknock quality of highly sensitive cracked fuels.

Problems of vapor-lock

The use of gasolines containing the lighter hydrocarbons also presents problems of engine design. High-volatility gasolines, under some conditions of service, may result in vapor-lock of fuel systems, but experience indicates that much can often be done in the design of both engine and chassis to increase their tolerance of more volatile fuels. When engines and vehicles can utilize the lighter fuels without the occurrence of vapor-lock, the advantages of easier starting and quicker warm-up are made available to users of automotive vehicles.

Volatility of gasolines is an important factor in connection with the formulation and utilization of "Ethyl" brand of antiknock compound. As a consequence it has played and will continue to play an important part in the program of the Ethyl Research Laboratories.

Research related to gasoline volatility is only one of the many services provided by the Ethyl Laboratories for oil companies. A comprehensive and continuous research program provides information which assists refiners directly in the economical production of satisfactory gasoline and furnishes basic data which serve as a foundation for development programs related to gasolines, engines, and crankcase oils.

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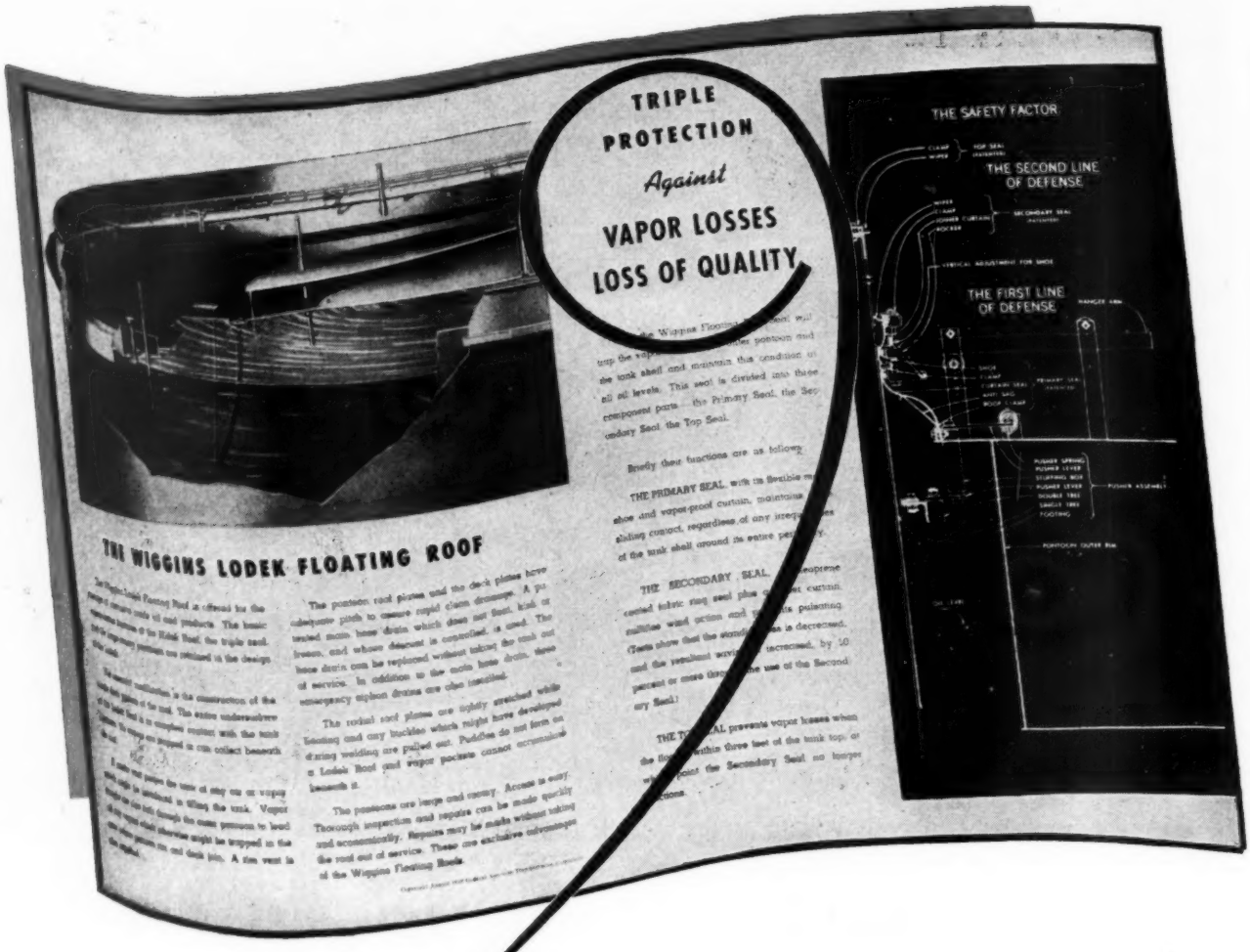

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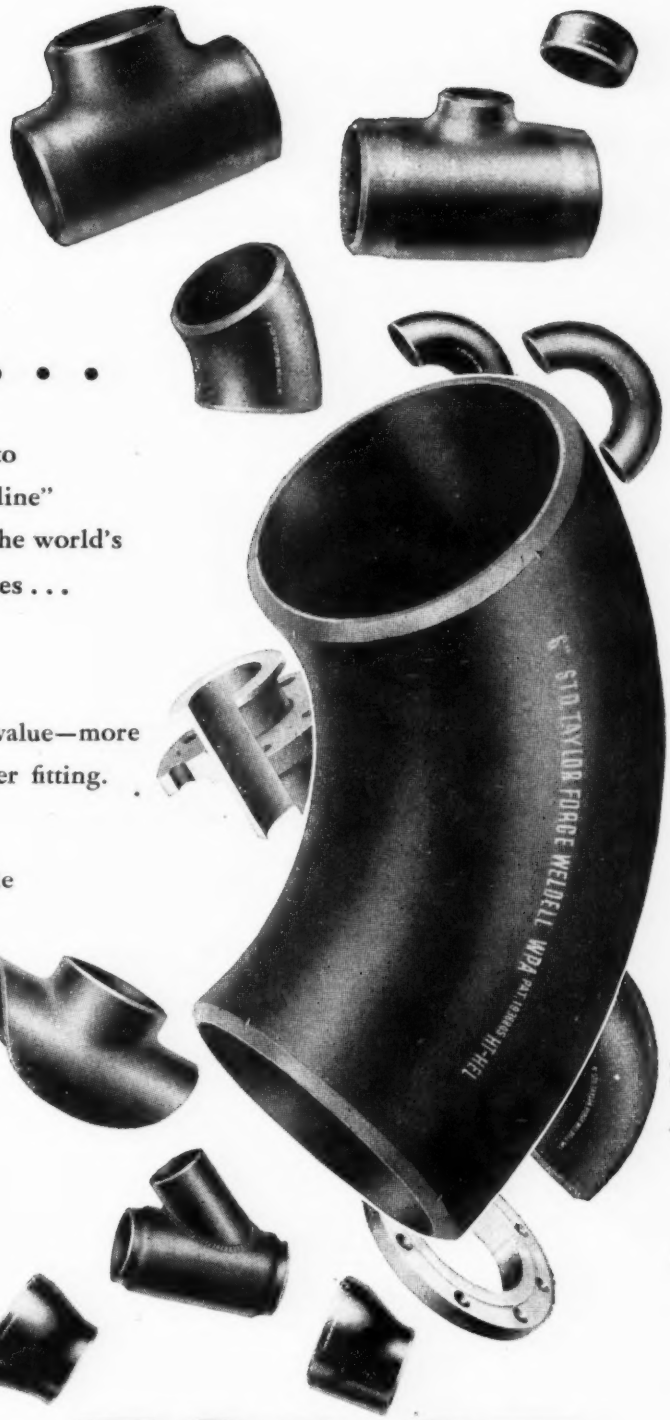

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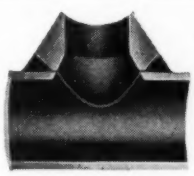

Fig. 1—Cut-away view of reducing size WeldOlet with welding outlet in place. The external rib and wide bases or footings of WeldOlets* eliminate the need for *extra supports* to take care of bending or vibrational stresses at crotch section, the point of greatest stress.

Fig. 2—Note blending of ear portion of welding fitting to run pipe. Extension of weld metal below inside scarfed portion of pipe insures all sections of joint greater than pipe wall thickness.

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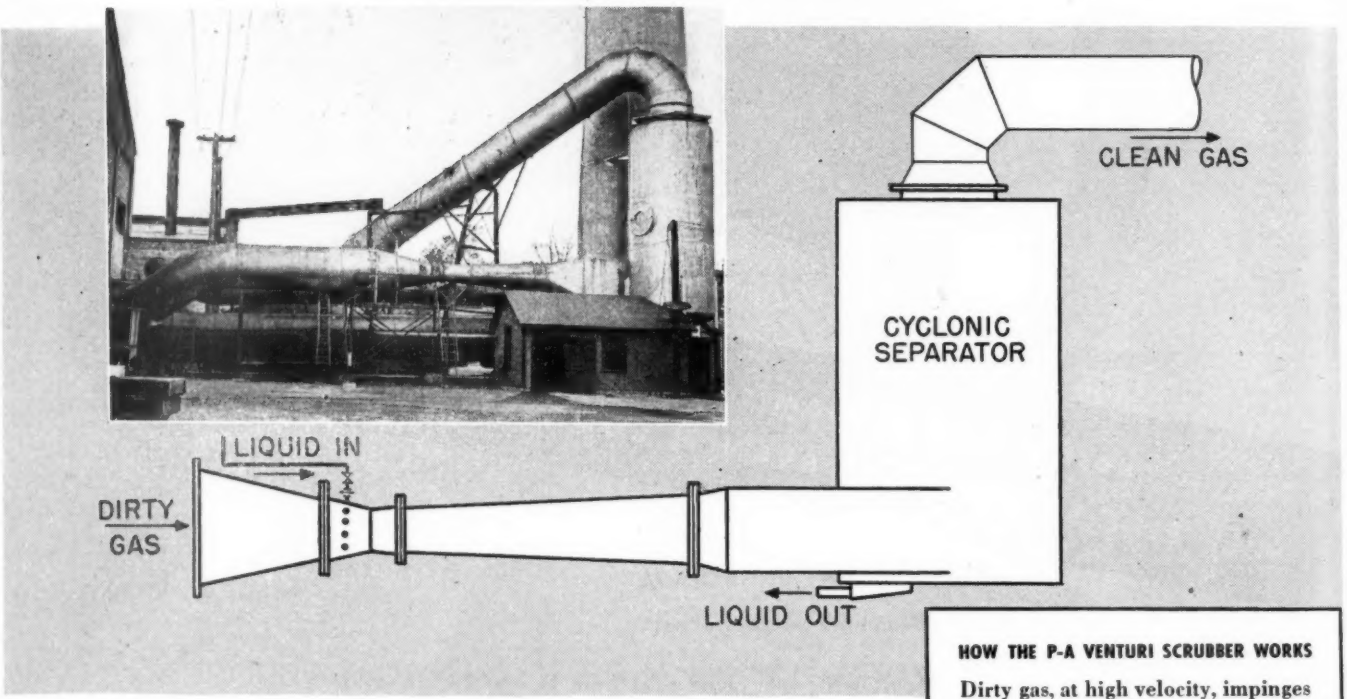

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Simple and Safe to Operate and Maintain—Any competent maintenance man can service a P-A Venturi Scrubber. No special skill is needed to repair equipment.

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What's Happening!

Important Current News Summarized for Refiners

MARKETS, PRICES

Continued downward price trend was indicated by reports from refiners and marketers in February. Heavy fuel prices fell in amounts ranging from 20 to 25c per bbl. at most coastal points. Light fuel oils in many marketing districts were offered at progressively lower prices, to move excessive stocks. Gasoline prices continued relatively firm along the Atlantic seaboard and the Gulf, but weakened markedly in the interior.

Terminal areas where weakening trend in prices was most apparent were New York harbor and Chicago. At New York, distillate prices were reduced up to 0.5c per gal. by Socony-Vacuum Oil Co. and Esso Standard. Esso also reduced heavy fuel at New York 10c per bbl.

Believing that price declines are not completed buyers were making commitments on a hand-to-mouth basis in order that price set-backs, if they occurred, would find them with minimum stocks. As a result, supplies at the refinery and terminal level remained relatively high, while stocks in the hands of jobbers and distributors declined.

Failure to move stocks in many cases has prompted sharp curtailments in refinery runs. High stocks of heavy fuel in turn have been reflected in reduced demand for heavy and sour crudes. Although gasoline stocks touched new peaks in February, many marketers said demand for gasoline could run ahead of supply this summer if the reduced output of the industry is maintained for a lengthy period.

• • •

LEGISLATION

Could Put U. S. in Oil Business: The administration's Economic Stability Program, now before Congress in the form of a bill (H.R. 2756), contains in its general provisions authority for the government to go into the oil business. Its projects would supplement those of private industry. Also, maximum prices could be fixed for commodities when shortages threatened the domestic economy or national security.

Power to initiate a commercial synthetic fuels industry, or even to expand petroleum refining, is implicit in a provision giving authority to build and operate new plant facilities to expand industrial capacity, provided private industry is unwilling, either with private capital or government loans.

Specifically under the bill, oil and other liquid fuels could be purchased at home or abroad, and allocated to private industry for use in meeting the quantity production goals set up.

Oil industry is "definitely a monopoly", Senate Small Business (Wherry) Committee charged in its lengthy final report, and proposed 1) divorcing crude and products pipe lines from shipper-owners, 2) study by Congress of "gas wastage," 3) prohibiting the Bureau of Mines from making monthly forecasts of supply and demand, and 4) investigating the activities of the Interstate Oil Compact Commission, among other findings.

No jurisdiction over natural gas producing and gathering for the Federal Power Commission is made plain in a bill now in congress (H. R. 1758), by Rep. Harris, Dem., Ark. Measure does not include, however, the controversial features of the Rizley-Moore bill of last year.

• • •

THROUGHPUT, 1949

Crude runs to stills early in February were around 5,400,000 b/d not much different than a year ago. Gasoline stocks in refiners' hands the middle of February were 117,000,000 bbls., about 10,000,000 bbls. larger than a year ago, and higher than during any point of the 1948 late winter. Distillate and residual stocks were more than 50% larger than the same period in 1948.

Data on actual consumption is not up to date. There may be some significance in the fact gasoline consumption, by the tax figures, for October, 1948, was only 3% greater than October, 1947; while for 10 months of 1948 consumption was over 8% larger than the same period in 1947.

Crude "In Abundance": Recognizing the surplus of present crude supply, the Texas Railroad Commission reduced the March allowable for the state by 200,000 b/d from February to 2,216,300 b/d. Actual production in March, 1948, was 2,430,000 b/d.

New Jersey Standard announced it was cutting its imports of Middle East crude by up to 50% and said,

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

if the trend of abundance continues, further reductions would be made. Creole Petroleum Co., of the same interests, reduced its takings of Venezuela crude by 108,000 b/d. Purchasers of Mississippi crude cut their takings for the second time. The Seep Agency cut the price of Pennsylvania grade crude by 44-45c a bbl.

Stocks of domestic and foreign crude in the U. S. around the middle of February stood at about 255,000,000 bbls., the highest since March, 1942. Because of large stocks and a smaller rate of increase in demand, total U. S. demand for crude in 1949 may be only about 2% above 1948.

Imports Blamed: As in years past when U. S. crude production backed up, producers, through their Independent Petroleum Assn., charged the condition was due to the growth in imports of foreign oil. They may ask Congress to impose quotas on crude imports, or restore the oil tariff to the former level of 21c a bbl. on crude and 2.5c a gal. on gasoline. The producers show that runs of foreign crude at U. S. refineries increased progressively during 1948 from 269,000 b/d in the first quarter to 402,000 b/d in the last quarter, and were even higher in the first months of 1949. They suggested to the Tariff Commission that a proper limit on imports this year would be 213,000 b/d.

• • •

EXPANSION

Magnolia Petroleum to operate a 30,000 MCF natural gasoline plant for Sholem-Alechem field, Okla., under unitization agreement. Laughlin Supply Co., Tulsa, contractors.

Unitized natural gasoline plant, designed for 159,000 MCF daily, in the Burnell-Pettus (Texas) field will be run by Stanolind Oil & Gas Co.

Imperial Oil will build gas gathering system, compressor station and natural gasoline plant handling 24,000 MCF daily in Leduc field, Alberta, Can.

San Jacinta Ordnance Depot, Houston, is re-erecting synthetic ammonia (from gas) plant formerly located at Louisiana, Mo. Hercules Powder will operate it; Girdler Corp., Louisville, has dismantling and re-erection contract.

• • •

U. S. OIL COMPANIES ABROAD

California Standard plans 35,000 b/d refinery and ocean terminal in Venezuela, refinery to be located near Lake Maracaibo.

Jersey Standard has acquired half interest in a new company in Italy which will own and operate two refineries, at Leghorn and Bari, with combined capacity of 16,000 b/d. Both plants, now processing Middle East Crude, will be modernized.

California-Texas Oil Co., Ltd., in partnership with Italian interests, has arranged for both refining and marketing operations in Italy. A 10,000 b/d refinery will be built to process Arabian crude.

Two new refineries for Argentina and one for Brazil, all with catalytic cracking units, are reported by M. W. Kellogg Co.

Belgium's 2500 b/d refinery at Antwerp has been reconstructed after war damage and is ready to resume operations.

• • •

RESEARCH

Military Notes: W. M. Holaday, director of research, Socony-Vacuum, is chairman of the new Fuels and Lubricants Committee of the National Military Establishment's Research and Development Board, to set up policies on research and development of fuels and lubricants for military utilization.

Pan-American Refining Corp. will sponsor a reserve quartermaster petroleum products laboratory at its Texas City refinery.

The Shell companies have adopted a budget of $24,000,000 for research in 1949. A substantial part will go to advance the basic research program at the Emeryville, Cal., laboratories of Shell Development Co.

Cities Service Oil Co. has completed its new technical service laboratory at its East Chicago refinery.

California Research Corp. is using radioactive piston rings in fuel and lubricant tests, and thus can measure as little as one-millionth of an ounce of metal worn from the rings.

The National Bureau of Standards has developed a new type consistometer for measuring flow characteristics of grease.

Phillips Petroleum Co. has found the manufacture of cold rubber can be greatly shorted by use of a chemical designated as "Diox."

General Motors Research Corp. will supply high compression engines to oil companies for testing purposes.

Patents Available; Sixteen war-seized patents useful in making styrene and other materials in the plastics field are available for licensing at nominal fee. Details can be had from Office of Alien Property, Department of Justice, Washington.

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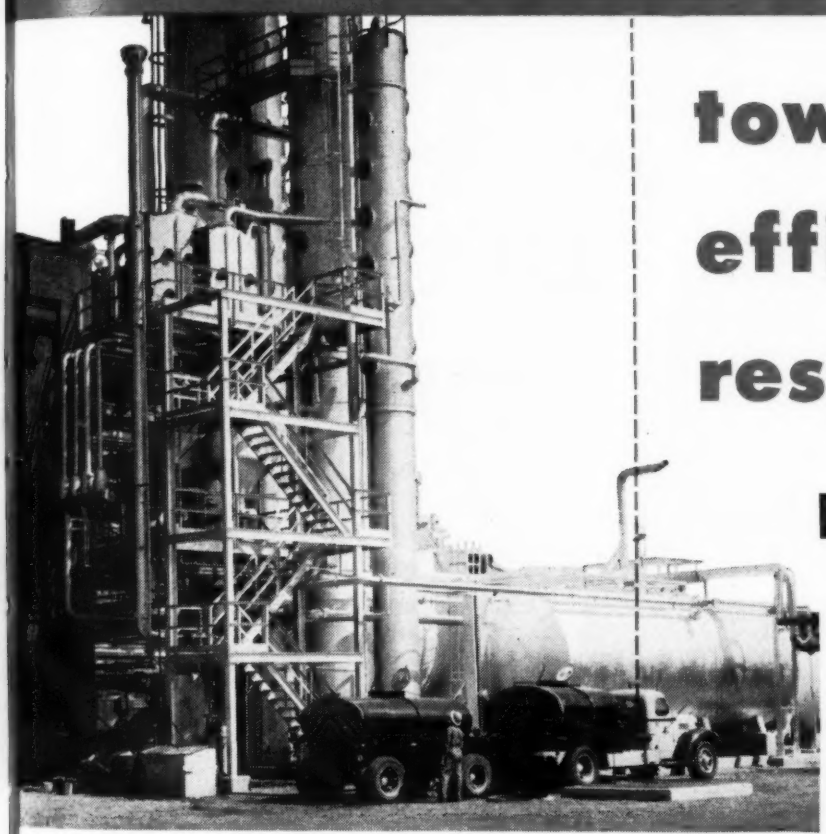

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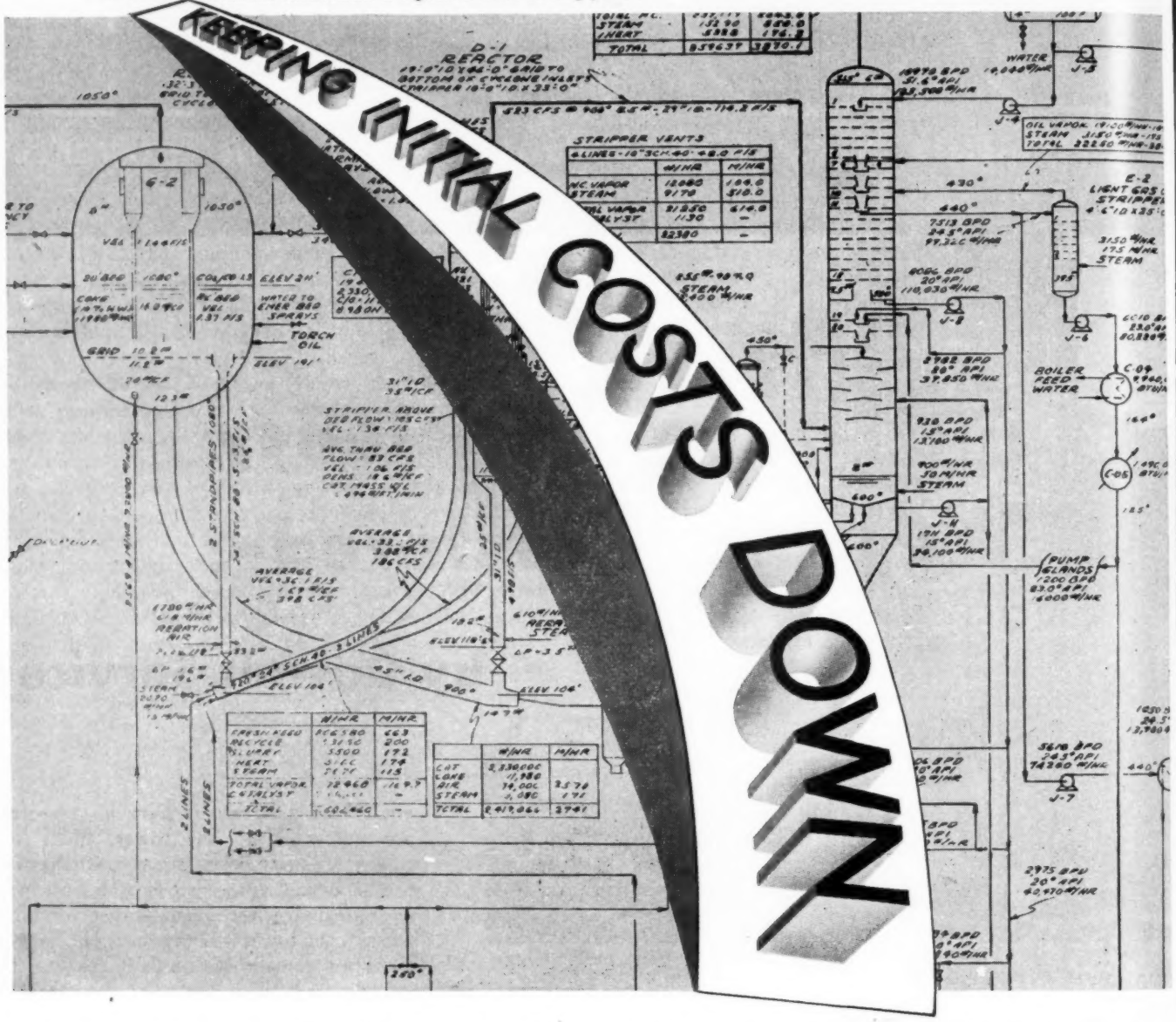
While it is axiomatic that return on investment—the *ultimate earning power* of a refinery unit when actually on stream—is the only true evaluation of competitive engineering recommendations, initial plant costs remain a major factor in refiners' decisions on plant installations. M. W. Kellogg takes specific steps to *minimize initial plant costs* consistent with the achievement of *highest ultimate earning power*.



KELLOGG starts to keep costs down at the precise point where a refinery project starts . . . in process design. For it is the quality of work in the design phase that establishes not only the ultimate earning potential of the unit but also the framework on which initial costs are predicated.

Quality of process engineering is, of course, dependent on the relative ability of individual engineers, their resources in data and experience, the emphasis put on process design by management . . . and, in the final analysis, on the organizational set-up within which the engineers work. Beyond the marked advantages Kellogg can show on the first three factors, its organizational set-up definitely assures *superior quality* in process engineering.

Continued and constant specialization by groups of engineers on every phase of petroleum processing is the keystone of this superiority. Only the volume of business that Kellogg enjoys permits the maintenance of an engineering organization numerically large enough to enable such specialization. The improvement in quality of engineering thus achieved needs no documentation . . . it is as obvious in refinery engineering as in every other branch of technical endeavor.

Superiority in process design is only the first in the continuing series of specific steps taken by Kellogg in the direction of low initial plant costs . . . a succession of individually significant contributions that accumulate substantial savings as each project moves through Kellogg's integrated organization.

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. . . IN PETROLEUM TECHNOLOGY

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

"Heat Pump" Gets Fuel Industries' Attention

AMONG THE FUEL INDUSTRIES, the public utilities, in the south at least are showing considerable interest in the "heat pump" as possibly offering increased competition to coal, gas and fuel oil for home heating, since its "fuel" is electricity.

Many technical papers on this heating-cooling mechanism have described it in much detail, but a recent article[1] has served to present many of the salient facts in a highly understandable manner. As stated, "the basic components are two heat-transferring coils, a compressor, and an expansion valve. A very cold refrigerant, such as Freon 12, is circulated through the evaporator coil where it picks up heat from the warmer surroundings. As it does so, the refrigerant evaporates into a gas and is drawn into the compressor.

"The work put into the compressor is used to raise the pressure and temperature of the refrigerant so that, when it is passed through the second coil, it loses heat to the cooler surroundings. As it loses heat, it condenses into a liquid at high pressure. The high-pressure liquid squirts through the very small orifice of the expansion valve and expands partially into a gas at a low pressure and a very low temperature. This low-temperature gas is drawn through the evaporator coil where it again picks up heat and starts its cycle all over again.

"Thus, the refrigerant picks up heat at the evaporator coil, has its temperature raised by the compressor, and releases the heat in the condenser coil. Heat is moved or pumped from one temperature level to a higher temperature level in much the same manner as water is raised from one level to another."

As may be noted, the device is essentially a refrigerator, but one which may be used either for heating or cooling (or both simultaneously, where advantageous). "Electricity is the only utility needed, so that its use offers the possibility of a truly all-electric house". Other cited advantages are the facts that no fire is involved; no chimney is required; no waste products, dirt, or odors are produced; and (again) that "an even temperature may be maintained the year around with very little attention."

"The amount of heat actually transferred by a heat pump is of paramount importance in any installation. It depends largely on the temperatures at which the heat is taken up and released. When the temperature of the evaporator coil is 60° F., it may take up four or five units of heat for each unit of electrical heat used by the compressor. This means that five or six times as much heat is gained as would be obtained at the same cost in conventional heating by electrical resistance. Under these conditions, electricity used in a heat pump is cheaper than most other fuels. On the other hand, when the evaporator coil operates at 0° F., the efficiency of the heat pump may be no more than twice that of resistance heating, and then electricity becomes an expensive fuel."

For home heating, the outside coil is located either in the air, in the ground, or in water, depending on the climate (air-to-air, ground-to-air, or water-to-air systems). The last two "have been successfully installed in most portions of the country, whenever the cost of drilling a well or burying a pipe in the ground is not excessive. . . . The cost of either the well (a minimum of a 200-foot well) or the buried pipe (approximately 1000 feet for a small unit) is usually $1000 for average conditions . . . A 3-hp. unit will heat and cool a small, well insulated house in an average climate, but a medium sized house may require a 5-hp. unit. . . .

"The minimum total cost of installing a heat pump is usually between $2000 and $2500. The cost increases as the size increases and as the cost of finding a suitable heat source increases." These figures, while apparently high, are really quite comparable to the joint costs of separate systems for heating and cooling.

Fig. 1, which appeared in this article[1] shows the comparative costs of using different fuels in a furnace in good condition, all compared with the relative cost of a well designed and well installed heat pump. "As an example of its use, it shows that if oil costs about 15 cents per gallon, a heat pump would cost about the same to operate provided the electricity costs about 1.8 cents per kilowatt hour."

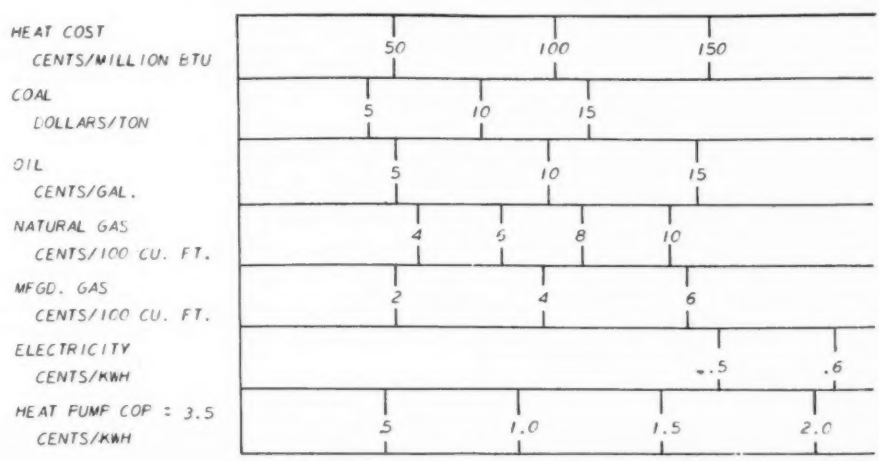

Fig. 1—Comparative costs of different fuels for home heating. A vertical line through the cost of one fuel shows what could be paid for any other fuel to obtain the same amount of heat at the same total cost

Relative Viscosity-Temp. Number for Lubricants

WITHIN THE PAST FEW DECADES, the petroleum industry has developed and standardized a considerable number of tests and specifications for its products, in order to promote uniformity and to pro-

[1] C. R. Freberg, "The Heat Pump," *Quarterly Bulletin of Southern Research Institute* 1, No. 4, 7-10 (1949).

vide means for comparison. The accepted tests and specifications are not always the most accurate, nor are they always extremely definitive, but their use has been of great value.

It is only natural, however that those who must use certain tests and specifications based on empirical considerations should conduct research on means to make them more exact and more scientific, or to develop alternative standards of superior utility. Octane-number-determination methods are typical of this unceasing search, as are alternative scales proposed and used for fuels of 100+ octane number.

As regards petroleum lubricants, viscosity index has long been a quality criterion, although many have pointed to a lack of correlation of this "property" with various desirable qualities. One recent paper(2) on this general subject seeks to overcome some of the "internal" failings of viscosity indices by proposing a relative viscosity-temperature number (R.V.T.N.) as a possible replacement. According to this paper the latter number "indicates how the kinematic viscosity *vs* temperature curve of a liquid compares with the curve for a hypothetical standard pure compound having the same viscosity at 210° F. This standard compound is chosen so that the dependence of viscosity on temperature is at least assumed to be possible for a pure compound."

Details of this idea and its theory and applicability are inappropriate here. If the industry finds it of general value, the R.V.T.N. might replace V.I. as a lubricant criterion. If it does not, its development will still have contributed to the background of the subject.

Govt. Reports Emphasize Synthetic Fuels Research

ATTENTION THESE DAYS to synthetic fuels developments is such that these rarely go unheralded in the petroleum press. There was a time when only workers in the field noted the release of pertinent information, but the entire subject is now of such intense technical and political significance that little is missed by the many now concerned with various aspects.

As is well known by all, the Bureau of Mines, under the Synthetic Liquid Fuels Act, is conducting a multi-million-dollar program on the synthesis of fuels from coal, oil shale, and similar materials. Details of this program are of great interest to the petroleum industry, members of which will want to study in detail the recent three-volume progress report for 1948 of the Secretary of the Interior.(3)

Of definite pertinence and value to its phase of the subject, also, is a recent Bureau of Mines review of the literature on the Synthine process and summary of several phases of Bureau of Mines research on its aspects.(4) Finally, another recent publication by this agency deals with the economics of producing heavy fuel oil by the hydrogenation of coal.(5)

Space does not permit even bare mention of the many fascinating aspects of the synthetic liquid fuels' field revealed in these reports. It should be noted, however, that such work as they report is a real contribution to the advancement of this field, just as publication of the results of this work is highly meritorious, Many members of the petroleum industry do not agree at all with Secretary of the Interior Krug that the government should build commercialized synthetic fuel plants if the petroleum industry does not find it economic to do this, but few will disagree that government research has its definite place and that such work as these reports reveal is well within the most limited definition of scope.

Gas Industry Research in the Petroleum Field

THE PETROLEUM AND GAS industries are closely related, especially that branch of the latter which deals with natural gas. It is not surprising, then, to note that much research in the gas industry is along the lines of petroleum industry endeavors, and that petroleum fractions are being studied as gas enriching materials and as raw materials for peak-load and base-load gas supplies.

Some details of the current work in this field were revealed in a recent account(6) of a meeting of the Technical Advisory Committee of the American Gas Assn., held at the Institute of Gas Technology, to discuss results obtained from research projects sponsored there by the AGA's Gas Production Research Committee.

One project under study deals with an evaluation of the enriching value of oils for carburetion. Excellent correlations using C/H ratios as criteria have been developed between easily measured physical properties of oils and their enriching values, tar yields and oil gas yields, and compositions. When supplementary experiments are completed, it is felt that this "new method of predicting the carbureting performance of oils using estimated C/H ratios obtained from simple physical tests will permit gas manufacturers to purchase the most economical raw materials and will furnish petroleum refiners with specifications based on physical tests used by both the gas and oil industries."

Another important program is concerned with the gasification of oils in the presence of a fluidized solid, which may serve the functions of a catalyst, a heat-carrying medium, or both. Design work has been completed for a pilot plant to test these fluidized oil gasification processes.

The removal from fuel gases of organic sulfur compounds is under study, attention being given to absorption in oil solutions of amines. Future work on this latter process will be conducted "to determine whether such absorption can be carried out efficiently in the presence of carbon dioxide and water and to discover chemical reagents suitable for thiophene removal." Analytical procedures developed in connection with this program are being applied in a number of gas plants to determine the individual organic sulfur constituents in the gases produced.

Sulfur poblems are also being attacked by a program designed to develop sulfur resistant catalyst for steam-air-hydrocarbon reactions, organic sulfur conversion, and the water gas shift

Much of this work and that on other projects dealing with fundamental research on carbon-oxygen-steam reactions and applied research on coal gasification is also of direct significance to the Synthine process as well as to gas production. It is evident that the gas industry is carrying on some excellent cooperative research on problems of importance to all its members, research which goes considerably beyond the fundamental-type projects sponsored by such petroleum industry groups as the American Petroleum Institute.

(2) R. T. Sanderson, "A Relative Viscosity-Temperature Number," *Industrial and Engineering Chemistry* 41, No. 2, 375-78 (1949).

(3) Anon., *Synthetic Liquid Fuels* 1948 *Annual Report of the Secretary of the Interior.* R.I. 4456, Part I, "Oil from Coal." R.I. 4457, Part II, "Oil from Shale." R.I. 4458, Part III, "Liquid Fuels from Agricultural Residues"; Part IV, "Secondary Recovery, and Petroleum Chemistry and Refining Research." Publications Distribution Section, Bureau of Mines, Pittsburgh, 1949. Gratis.

(4) H. H. Storch, *et al., Synthetic Liquid Fuels from Hydrogenation of Carbon Monoxide.* Part 1, "Review of Literature; Bureau of Mines Research on Effect of Catalyst Preparations, Reduction, and Induction Procedures on Activity; Correlation of Physical Properties of Catalysts with Their Activity." Bureau of Mines Technical Paper 709, Superintendent of Documents, Washington, 1948, 213 pages. 50 Cents.

(5) L. L. Hirst, *et al., Estimated Cost of Producing Heavy Fuel Oil by Hydrogenation of Coal.* R.I. 4413, Publications Distributions Section, Bureau of Mines, Pittsburgh, 1948. 53 pages. Gratis.

(6) Anon., *Institute of Gas Technology News Letter* 1, No. 3 (1948).

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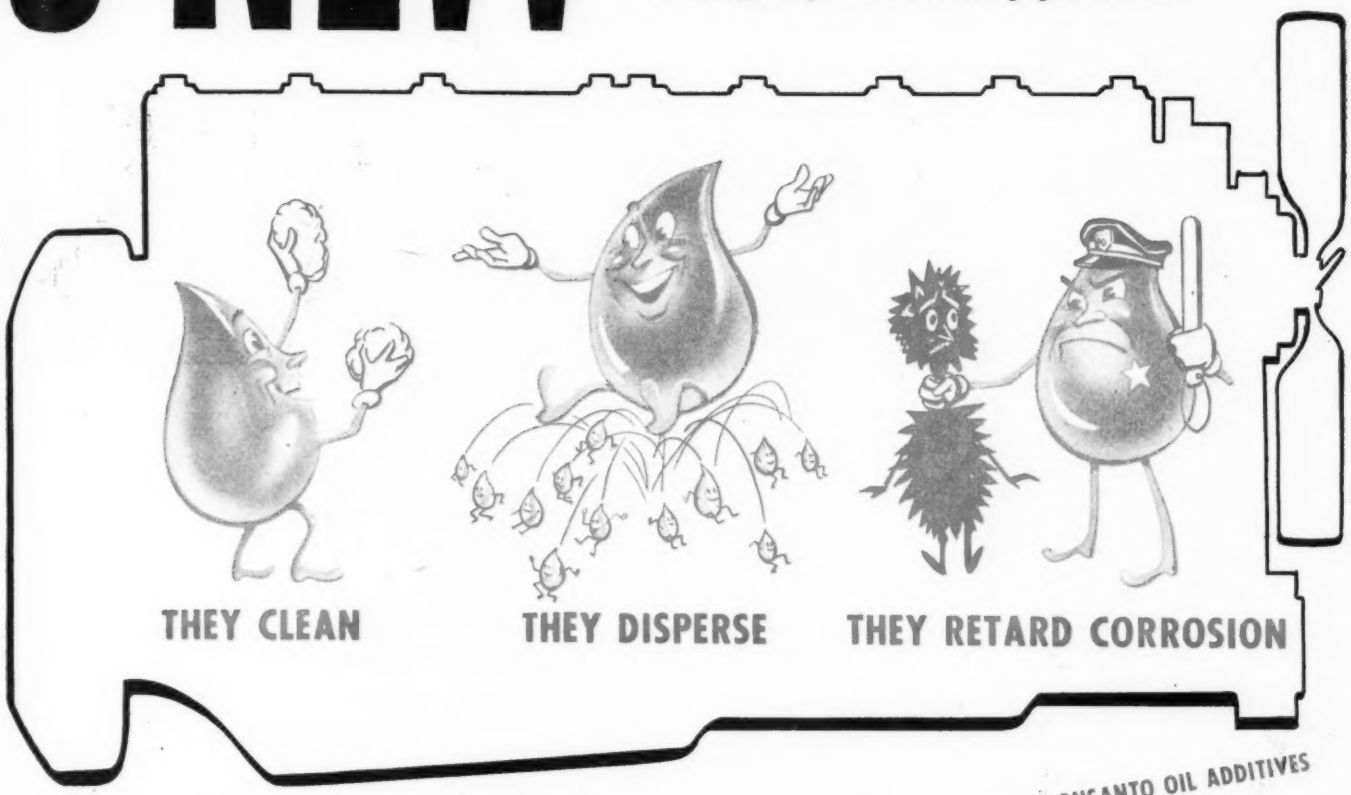

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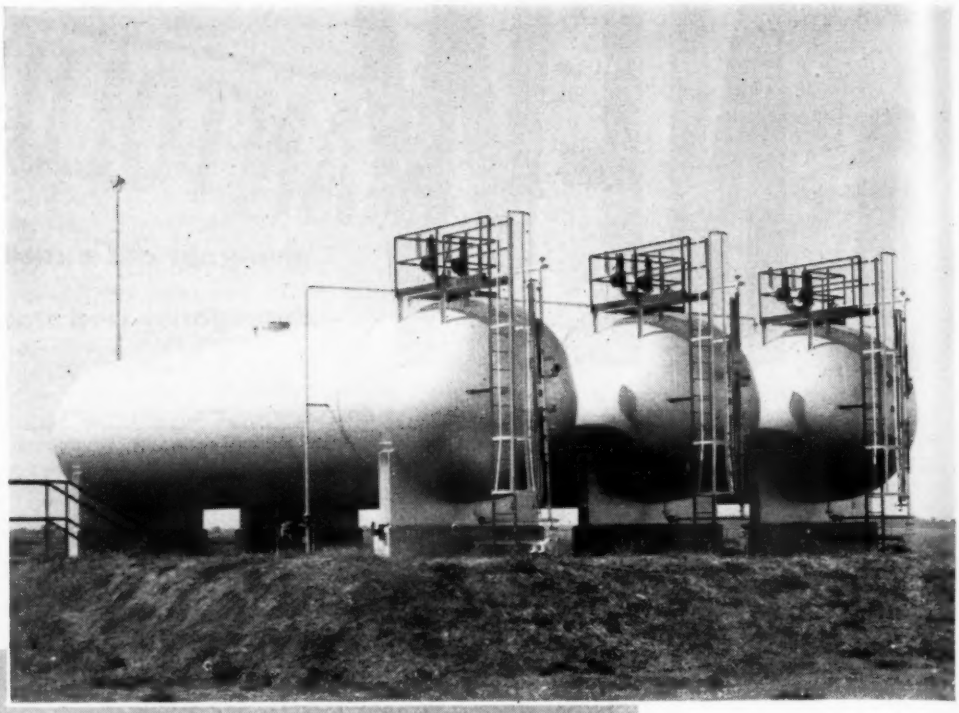

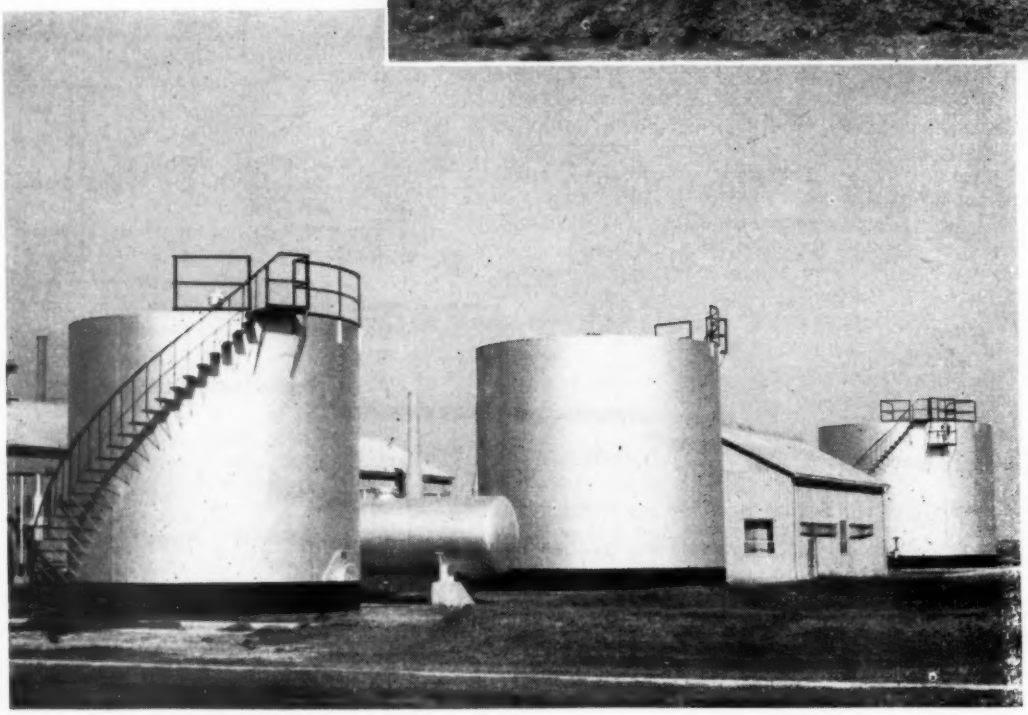

Top view: Three 12-ft. diam. by 62-ft. horizontal pressure vessels used for butane storage at 80 lbs. per sq. in. pressure, at the Humble Oil & Refining Company's plant at Anahuac, Texas. Adjacent view: Three flat-bottom tanks, which are, left to right, a 1,000-bbl. oil absorption tank, a 2,000-bbl. water tank, and a 3,000-bbl. raw water tank.

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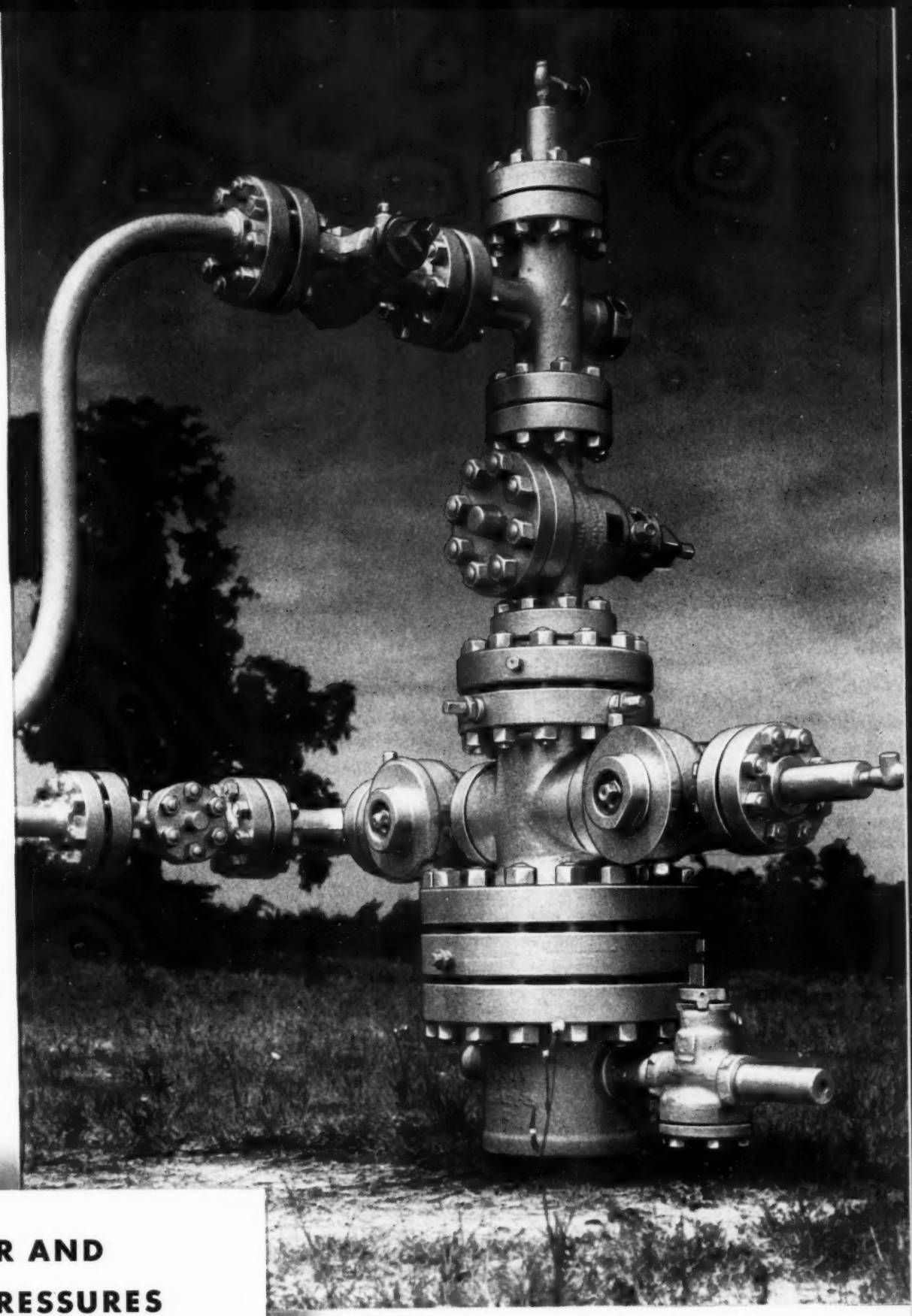

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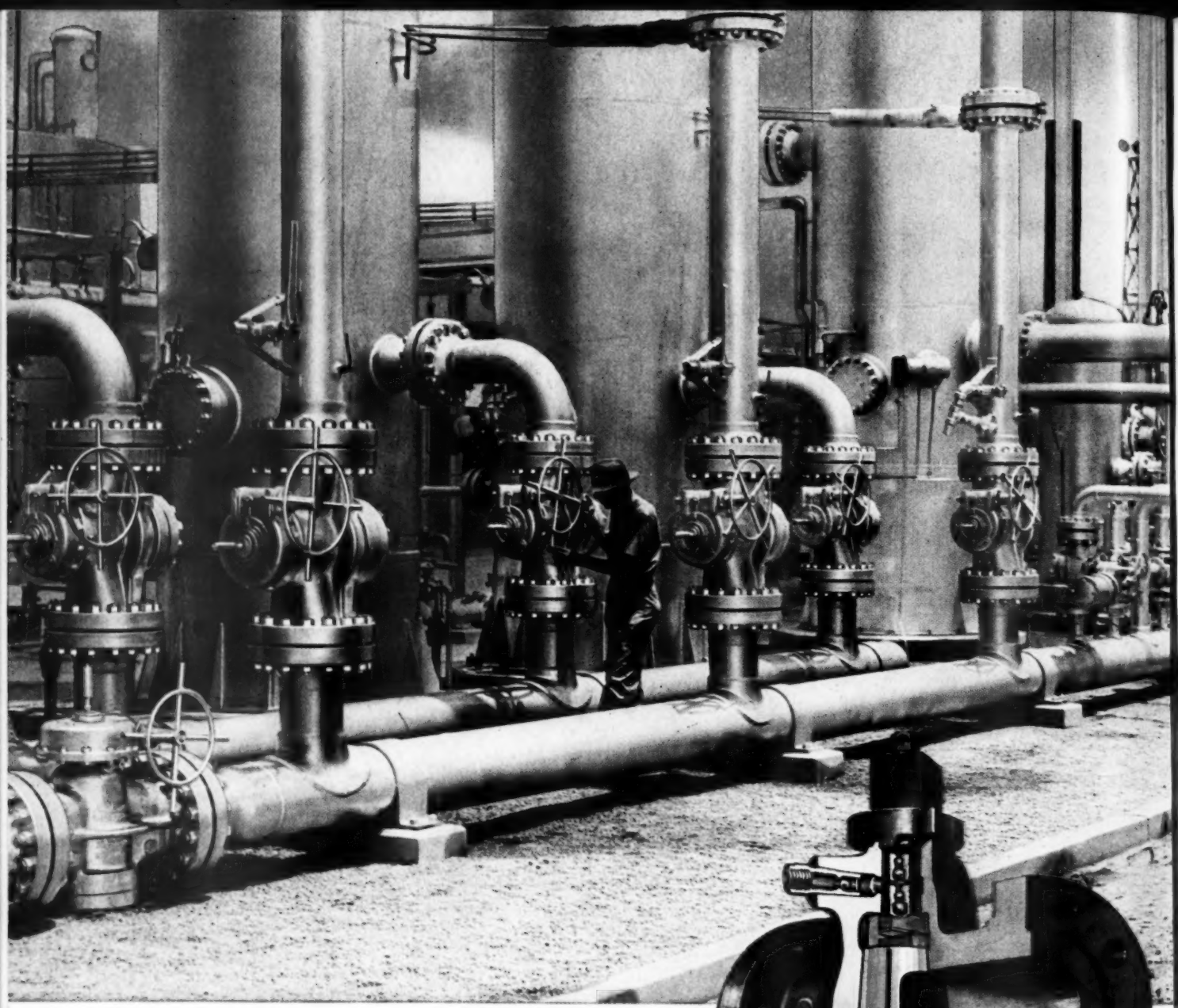

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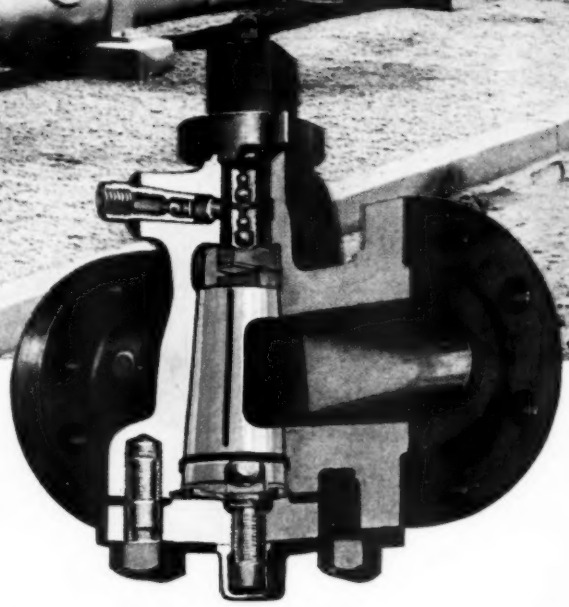

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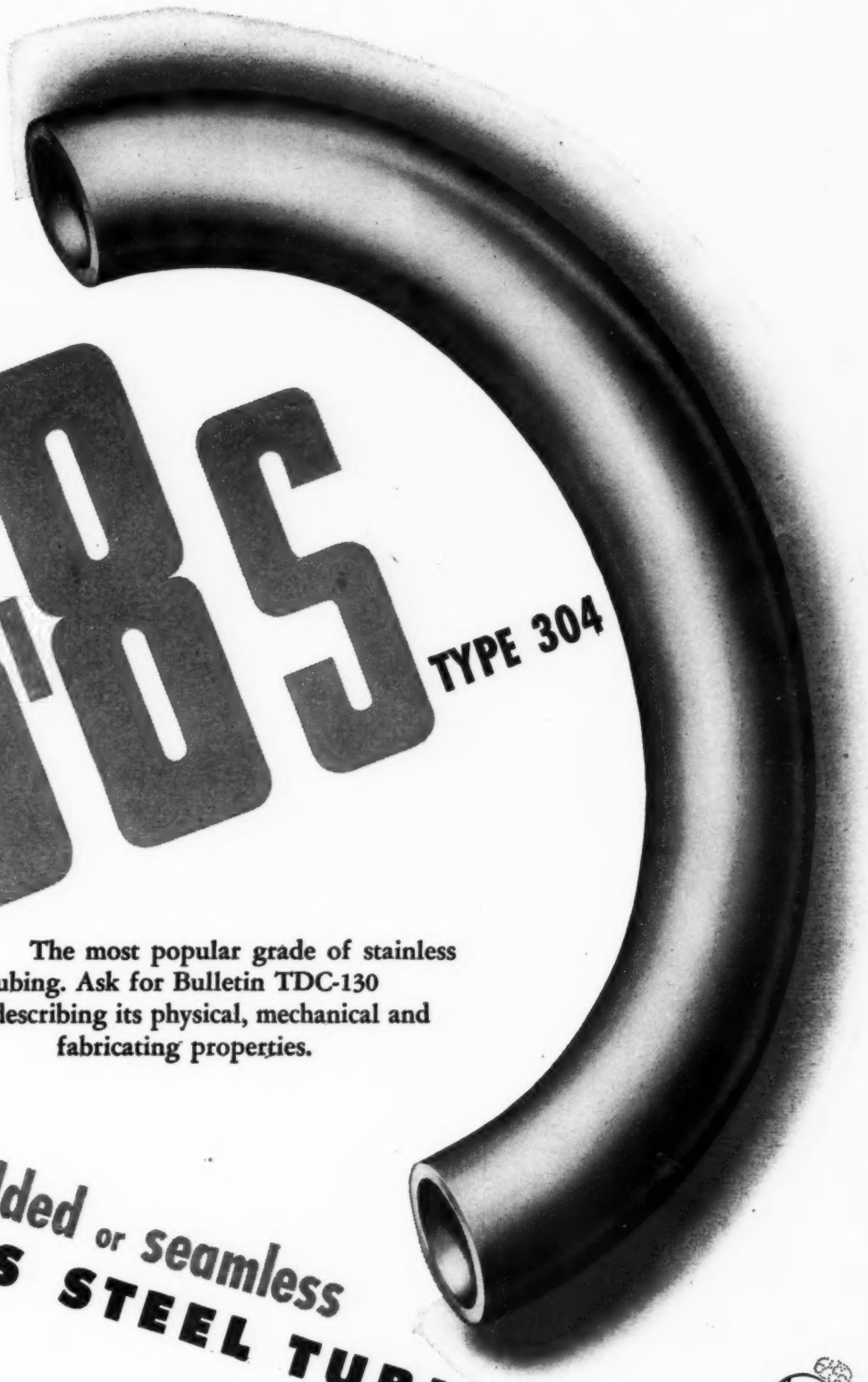

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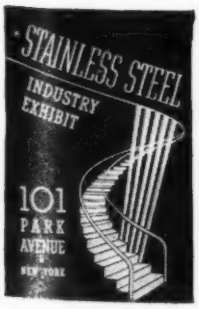

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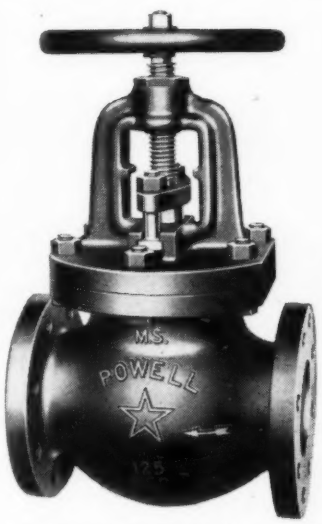
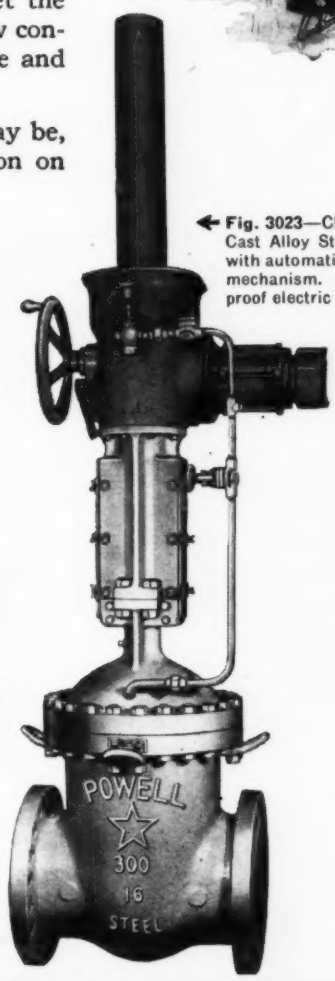


Fig. 241—Large 125-pound Iron Body Bronze Mounted Globe Valve. Made in sizes 2" to 16", inclusive. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

Fig. 1375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze seat rings and disc.



← Fig. 3023—Class 300-pound Cast Alloy Steel Gate Valve with automatic steam sealing mechanism. Has explosion proof electric motor operator.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge. Also available in All Iron for process lines.

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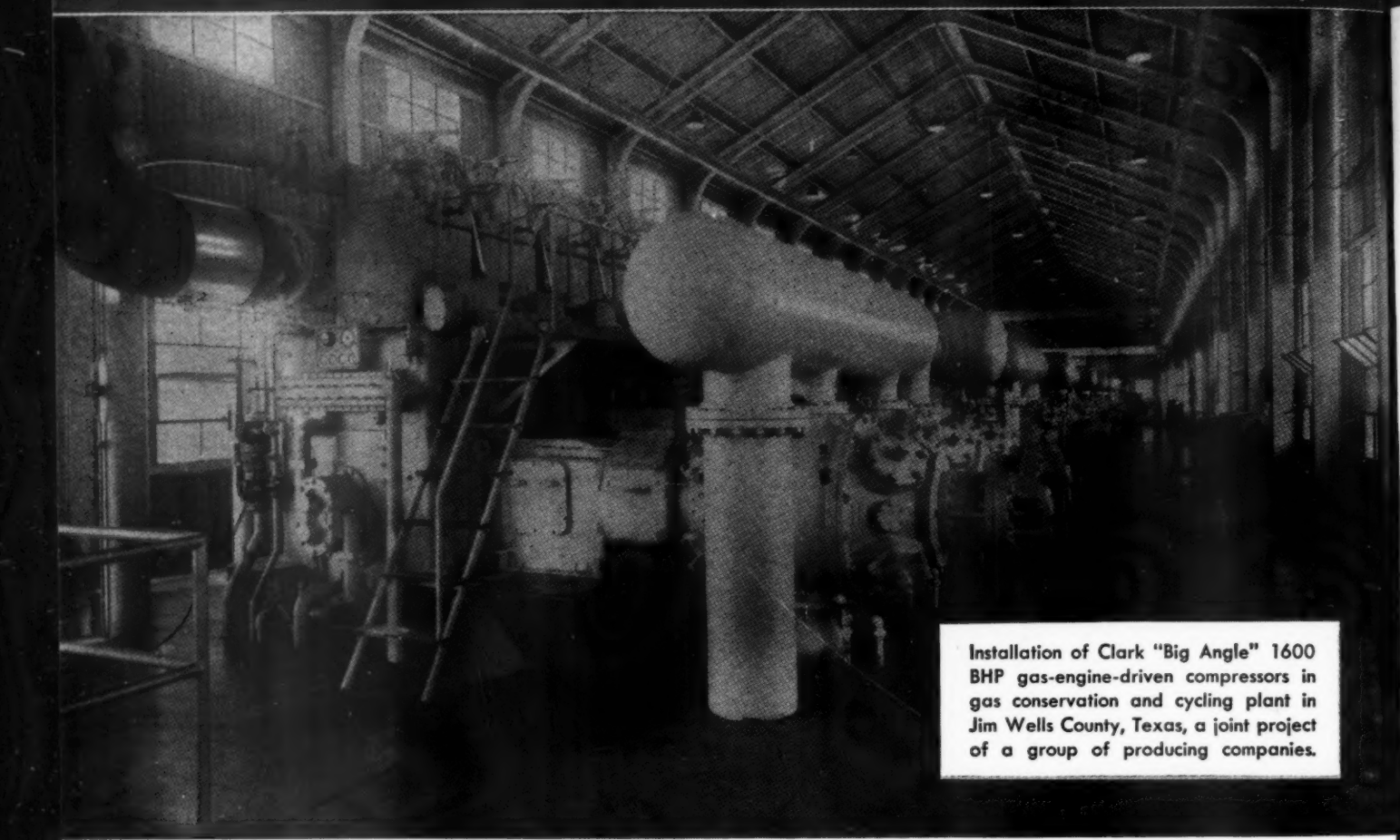

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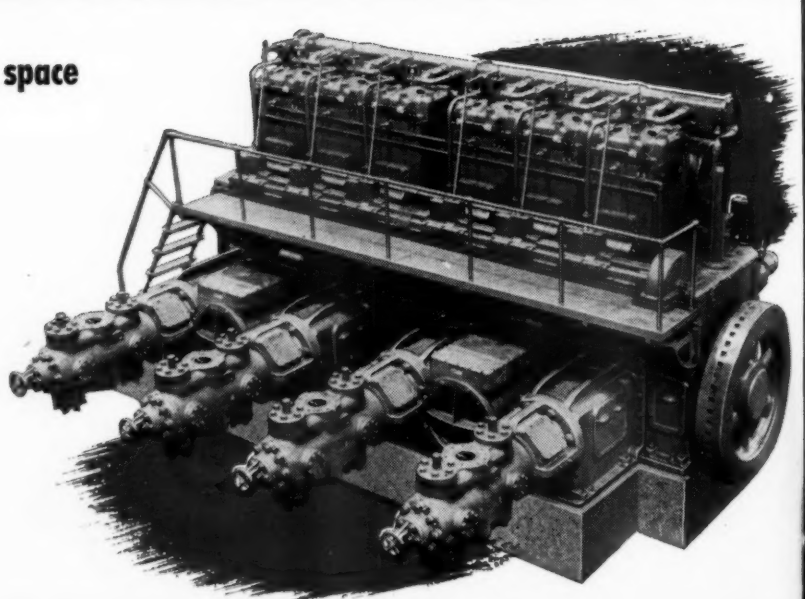

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This fine, modern plant is equipped with eight Clark "Big Angle" 8 cylinder, 1600 BHP Compressors, with more units to be added. Residue gas is derived after extraction of natural gasoline and other products from casinghead gas produced with oil. The flare gas thus conserved is compressed in three stages up to 1000 psi and discharged into a pipe line for transmission.

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This large scale conservation and cycling project shows what can be accomplished by a unitization plan through co-operation of the various companies who have an interest in a given field.

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For complete description and dimensional drawings, with other useful data, send for bulletin on the Clark "Big Angle".

CLARK "BIG ANGLES"

Q:
What single factor has done the most to bring economical, profitable operation within the reach of all refiners?

UOP

Converted War Refinery Gives Sunray 20,000 b./d

By F. L. Martin
Executive Vice-President
Sunray Oil Corporation

THE Sunray refinery near Duncan, Okla., is currently processing approximately 20,000 barrels of Oklahoma crude every day to produce a wide range of readily marketable products—not 100-octane gasoline for which the plant was originally designed.

F. L. Martin

Built and operated during the war by Associated Refineries, this plant had been producing about 250,000 barrels of aviation gasoline a month. When it was shut down at the close of the war, doubt existed generally that it could be operated profitably under peacetime conditions.

Purchased in 1947

After consultation with the refinery's designers, Universal Oil Products Co., we decided to negotiate its purchase which was completed in October 1947. Conversion to commercial operation, making the greatest possible use of existing facilities, was begun at once under Universal's direction.

This is what we had purchased: a two-stage fluid catalytic cracking plant with a charging capacity of 12,000 barrels of fresh feed per day; a gas concentration system; a hydrogen fluoride alkylation unit which produced 2,500 barrels per day of alkylate; an isomerization plant capable of producing 300 barrels per day of isobutane; and a modern boiler plant.

Auxiliary equipment included three large forced-draft cooling towers necessitated by the heavy water requirements of the alkylation plant. Tankage included rundown, charging stock and product storage tanks. There were, as well, buildings and shops and a large loading dock.

An adequate supply of crude was at hand from the nearby Velma field and low cost electricity and natural gas were available.

Objections to Overcome

Our new refinery possessed no pipe lines to afford economical transportation for crude coming in and product going out, inasmuch as it had been designed to operate exclusively on gas oil delivered by truck, and to produce aviation gasoline shipped by tank car.

The wartime equipment included no topping unit, an essential requirement for a refinery running crude oil. There was no desalting equipment, needed in treating Velma crude. A vacuum

(Advertisement)

unit was lacking for the recovery of heavy, waxy gas oil from topped crude. A vis-breaking operation would be required to make a salable fuel oil from the heavy residue. There was no provision for treating the products of crude distillation.

Changes Called For

Our original Sunray refinery with a capacity of 12,000 barrels per day is located at Allen, Okla., some 100 miles from Duncan by pipe line route. One of the first requirements was to connect the two refineries for product exchange and storage. At the same time, a short line was needed to bring crude from the Velma field to Duncan.

As operated in wartime, the light gases from the cat cracker were charged to the alkylation unit to produce aviation alkylate. Since that procedure was not applicable to our new operating schedule, it was desirable to install a polymerization unit and a propane separation unit to prepare this product for the LPG market.

We decided to operate the cat cracker as a single stage unit and extensive changes in both the reactor and regenerator sections were necessary. The large feed heater, no longer required, and the retreat fractionating column, were taken as basic elements for a new topping unit.

In order to increase the crude capacity of the converted plant it was decided to preflash the crude. A heat exchanger from the alkylation unit and the debutanizer tower from the gas concentration system were combined into a preflashing unit. Thus, about 15 percent of light straight run gasoline is flashed off when the charge to the crude unit is preheated to about 400°F. This improvised crude unit and the preflashing system give the plant its 20,000 b/d crude capacity.

A large settler from the alkylation unit was converted into a vacuum unit; a poly unit was built to handle the gases from the crude unit and the cat cracker; a propane unit was installed. In all these, existing equipment was utilized to a great extent.

Profitable Operation

Actual construction began in October 1947, and 90 days later the topping operations were processing 18,000 bbls. per day. On April first the vacuum vis-breaking operation started producing feed stock for the catalytic cracker, and on June first the catalytic cracker was on stream.

The cooperation received from Universal Oil Products Co. completely changed the plant from a wartime operation to a practical commercial refinery within nine months, including 98 miles of six-inch products pipe line construction.

This conversion at Duncan has resulted in a very successful and profitable operation for Sunray, and at the same time has balanced refinery run to crude oil production.

(Advertisement)

A UOP Service - including research, development, engineering, processes and field service.
UNIVERSAL OIL PRODUCTS COMPANY
UOP
General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILL., U.S.A.
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Universal Service Protects Your Refinery

55 GALLONS OF WORKING EMULSION-BREAKER

IN EVERY *Visco* BARREL!

●Putting Visco dehydrating and desalting chemicals to work for you is an absolute guarantee (in writing, if you wish) of *consistently uniform* emulsion-breaking efficiency. Every one of the big blue Visco barrels contains 55 gallons of *working* emulsion-breaker... to give you minimum cost per barrel of dry oil. Call Houston, CAPITOL 7300, collect, for prompt action or more details on Visco chemicals and field service.

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INCORPORATED
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Visco... **CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS**

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating compounds for use in the breaking and resolving of oil emulsions, and to grant licenses for such use, under the following United States patents: 1,860,562; 1,860,563; 1,912,330; 1,937,259; 2,050,439; 2,050,640; 2,206,589; 2,214,783; 2,214,784; 2,225,189; 2,303,414; 2,307,813; 2,318,034; 2,318,035; 2,321,056; 2,335,554. Re. 20,717 and patents pending. Any purchaser of Visco Oil Treating compounds is authorized to use the same in the treating, breaking and resolving of oil emulsions in accordance with the above patents. The royalty for such use is included in the purchase price. Visco Products Company is authorized to and is willing to grant licenses on a royalty basis, to all companies, and to others desiring to practice the patented subject matter, under any and all of the above patents, permitting the user to purchase the oil treating compounds at will from any vendor, and to prepare the compounds for use under the above patent or patents, at a royalty charge of 20 cents per gallon. Application for license should be made to **Visco Products Company**, Houston, Texas.

The customer knows what he wants . . .

a complete petroleum refinery

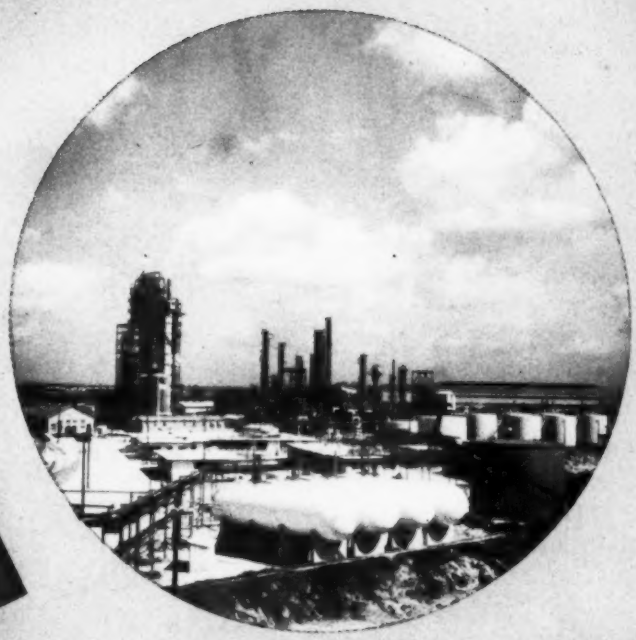
process units—tankage—maintenance shops—loading and unloading facilities—storage—administration and laboratory buildings—gas plants steam and power—cooling water systems—cooling towers, etc.

design

engineering

fabrication

construction



The customer gets what he wants . . .

when his experience and knowledge is joined with that of an engineering service which has built over 400 process units . . . complete refineries and chemical plants.

Collaboration pays off—in time and money.

FOSTER WHEELER CORPORATION

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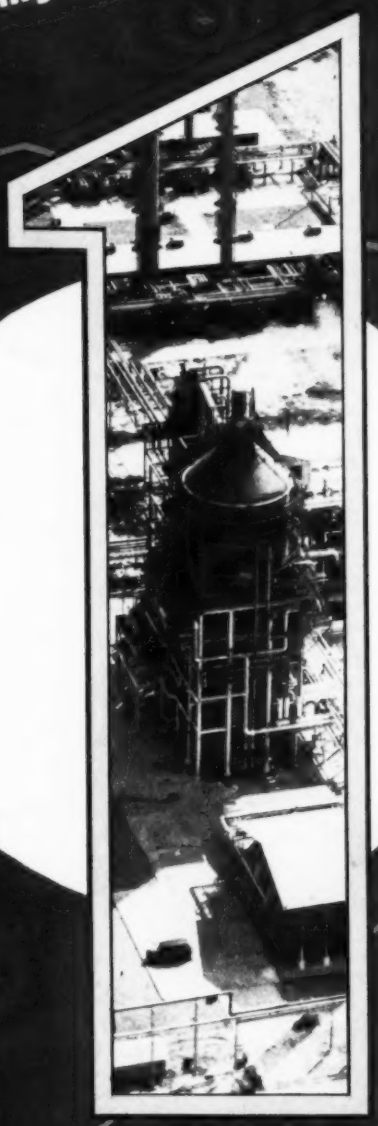
one . . . complete . . . engineering and construction service



complete petroleum
refineries and
chemical plants

one contract
one contractor
one constructor

FOSTER WHEELER CORPORATION
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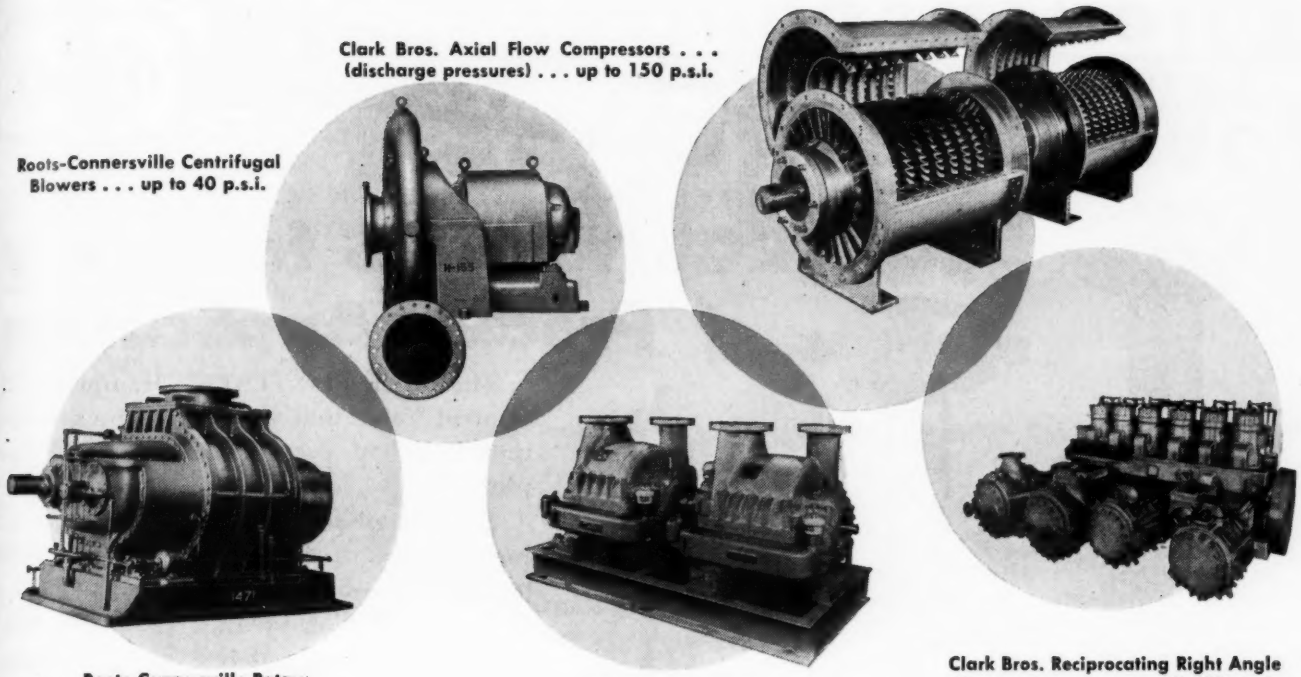

Clark Bros. Axial Flow Compressors . . . (discharge pressures) . . . up to 150 p.s.i.

Roots-Connersville Centrifugal Blowers . . . up to 40 p.s.i.

Roots-Connersville Rotary Positive Blowers . . . up to 10 p.s.i. (discharge pressure)

Clark Bros. Centrifugal Compressors . . . above 40 p.s.i.

Clark Bros. Reciprocating Right Angle Compressors . . . up to 10,000 p.s.i.

AREAS OF OVERLAP

ARE WHERE YOU BUY RIGHT OR WRONG

Where pressures overlap, you buy more than a piece of equipment. You buy engineering judgment from the salesman.

Why buy his salesmanship?

Dresser Industries deliberately engineers a line of types. These cover the areas of overlap so that Dresser offers you unprejudiced decisions. Then engineering is not compromised for the sake of a sale.

If you buy from a man carrying a torch for one special type of equipment, his decision, of course, will go toward his equipment, in any area of alternate decision. Whereas a smaller unit might serve as well—maybe a different type would serve better, enabling economies elsewhere. How can you be sure unless you deal with a company that can afford to be unbiased?

Before you buy any equipment, write for comparative data on the overlapping FIVE TYPES made by Dresser Industries. State which type you think comes closest to your needs.

R-C ROTARY POSITIVE BLOWERS are built in capacities from 10 CFM to 50,000 CFM. Drives may be from direct-connected steam or gas engine, moderate-speed induction or synchronous motor, or through V-belt or reduction gear set from high-speed motor or steam turbine. Write for details.

R-C CENTRIFUGAL BLOWERS are essentially high-speed units, for direct connection to electric motors or steam turbines, or with impeller mounted directly on extended motor shaft. Built in single stage or multi-stage designs, their capacities range from 2,000 CFM to 100,000 CFM. Write for data.

CLARK MULTI-STAGE CENTRIFUGAL COMPRESSORS, a complete line for higher pressure ranges, primarily suited for compression of air and gases in oil refining and processing industry. Write for booklet with complete details and sizes.

CLARK AXIAL FLOW COMPRESSORS, new complete line of high-efficiency units for volume range from 20,000 to 300,000 CFM. Advantages in reduced floor space, electric, steam or gas turbine drive, light weight, low maintenance, high temperature rise without inter-cooling. Write for booklet of complete details.

CLARK BROS. RECIPROCATING R A COMPRESSORS, 2, 3, 4, 5, 6, 8, 10 cylinders; 75 to 4,000 BHP, most compact heavy-duty Right Angle compressors ever built. The ten major advantages and the details of saving with smaller building and less maintenance are set forth in Clark's booklets. State your conditions and write for a copy.

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Bradford, Pa.

DRESSER Mfg. Company, Limited
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INTERNATIONAL Derrick & Equipment Co.,
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Columbus, Marietta & Delaware, Ohio

DRESSER INDUSTRIES, INC.
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KOBE, Inc.
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PACIFIC Pumps, Inc.
Huntington Park, Calif.

ROOTS-CONNERSVILLE Blower Corp.
Connersville, Ind.

SECURITY Engineering Co., Inc.
Whittier, Calif.

STACEY BROS. Gas Construction Company
Cincinnati, Ohio

Stacey-Dresser Engineering Division
Cleveland, Ohio

AUTOMATIC CONTROL EQUIPMENT

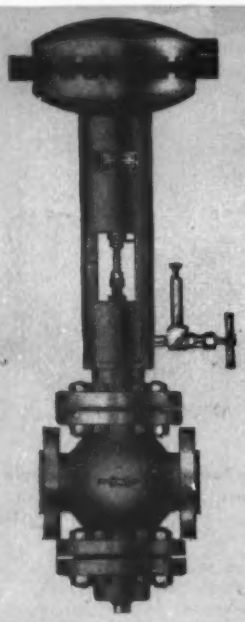
ENGINEERED DESIGN BY **HAMMEL-DAHL**

CONTROL VALVES for every Process Application

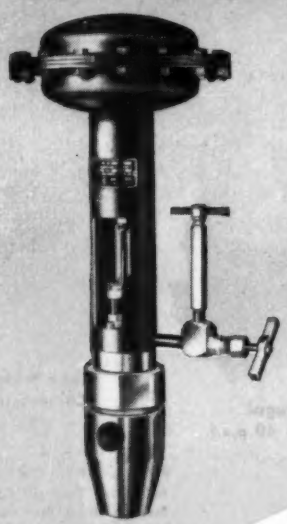
There is a FLO-TESTED Hammel-Dahl Control Valve that will meet the exact requirements of every Process Control Application.

Engineered design for a maximum working pressure of 15,000 PSI and temperatures from —300°F. to 1200°F.

Size range from ½" thru 12" (C_V: 0.001 — 1440) will accurately control extremes in flow, temperature and pressure on air, water, steam, oil or gas service.

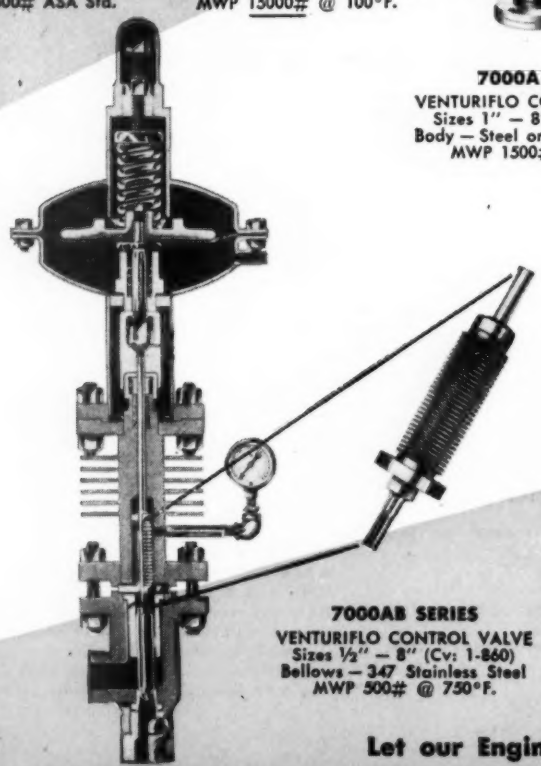


3000 SERIES
CONTROL VALVE
Sizes ½" — 12" (Cv: 1-1440)
Body — Cl, Steel or Bz.
MWP 1500# ASA Std.



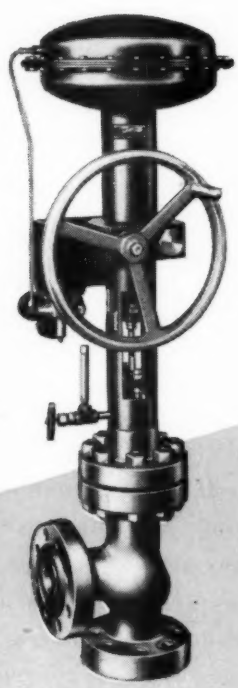
7000 SERIES
MICROFLO CONTROL VALVE
Sizes ½"—1" (Cv: 0.001-0.63)
Body — Steel or Stainless Steel
MWP 15000# @ 100°F.

7000A SERIES
VENTURIFLO CONTROL VALVE
Sizes 1" — 8" (Cv: 1-860)
Body — Steel or Stainless Steel
MWP 1500# ASA Std.



7000AB SERIES
VENTURIFLO CONTROL VALVE
Sizes ½" — 8" (Cv: 1-860)
Bellows — 347 Stainless Steel
MWP 500# @ 750°F.

3000BZ SERIES
ALLOY CONTROL VALVE
Sizes ½" — 10" (Cv: 1-1000)
BODY — Any Castable Alloy
MWP 300# ASA Std.



7000HP SERIES
VENTURIFLO CONTROL VALVE
Sizes 1" — 8" (Cv: 1-860)
Body — Steel or Stainless Steel
MWP 1500# ASA Std.

Let our Engineers solve your Control Valve problem

HAMMEL-DAHL COMPANY

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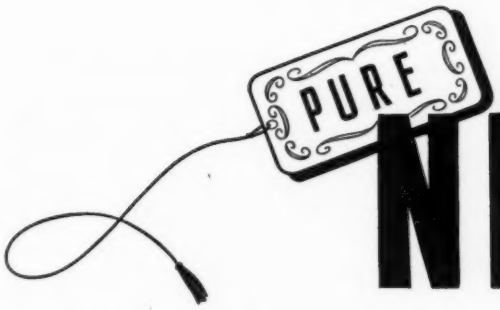
In Canada, Railway & Power Engineering Corporation, Ltd.



NICKEL

Sheet, Strip, Rod, Wire, Tubing, Clad-steel, Castings.

Its practical cost astonishes users almost as much as its distinctive characteristics

CHEMICAL COMPOSITION

The nominal composition of commercially pure wrought Nickel is:

Nickel*	99.4%
Copper	0.1
Iron	0.15
Manganese	0.2
Silicon	0.05
Carbon	0.1

**Including cobalt*

PHYSICAL CONSTANTS

Specific Gravity	8.89
Density, lb. per cu. in.	0.321
Melting Point	2615-2635°F. / 1435-1445°C.
Specific Heat at (80-212°F.)	0.130
Heat Expansion Coefficient at (80-212°F.), per °F.	0.0000072
Thermal Conductivity at (80-212°F.), Btu/sq. ft./hr./°F./in.	420
Electrical Resistivity at 32°F., ohms/cir. mil. ft.	63
Temperature Coefficient of Electrical Resistivity per °F.	0.0022-0.0028
Modulus of Elasticity in tension, psi	30,000,000
in torsion, psi	11,000,000
Poisson's Ratio	0.31

MECHANICAL PROPERTIES

The following figures for Standard Cold Rolled Sheet are typical, though the figures will vary for different forms and tempers.

Tensile Strength	55,000-80,000 psi
Yield Strength (2% offset)	15,000-45,000 psi
Elongation in 2 in.	50-35%
Rockwell B Hardness	40-70

AVAILABLE FORMS

Wire — Bar — Plate — Pipe
Rod — Angles — Sheet — Strip
Seamless and Welded Tubing
Sand and Precision Castings
Clad-Steel Plate and Strip Welding Rods

It is a strange and interesting metal, Pure Nickel. A kin of both the base metals and the precious metals. Among all the elements, no other metal possesses its unique combination of so many different and uncommon properties.

- It is highly resistant to corrosives that destroy many other metals—alkalies, many acids, salts, organic compounds, fumes.
- It has mechanical properties like those of structural steel.
- Yet it is so ductile that it can be worked into the most intricate and delicate shapes that are practical in metal.
- It protects the purity of sensitive foods, beverages and pharmaceuticals against contamination.
- It often provides a faster rate of heat transfer than metals with equal heat conductivity.
- Its special electronic properties make it a standard metal for electronic uses.
- It offers rare electrical and magnetostrictive characteristics that often give theoretical ideas a birth of practical value.
- It can be exposed to temperatures ranging into yellow heat and even hotter in the absence of sulphur.
- At sub-zero temperatures its strength increases without change in ductility and toughness.
- It is a standard metal for the cladding of steel, and as a base for gold, palladium and silver-clad products.

And one of the most valuable of all its features is the fact that Pure Nickel is a practical metal at a practical price.

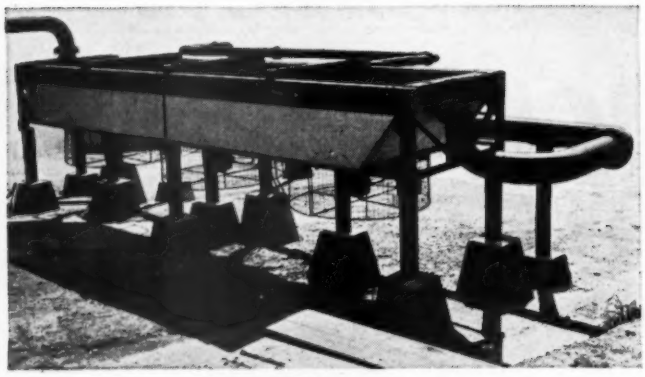
Does it stimulate an idea of how you may find an easy answer to a difficult problem?

Our technical bulletin "Engineering Properties of Nickel" gives the important facts you want. It's yours for the asking.

The International Nickel Company, Inc.

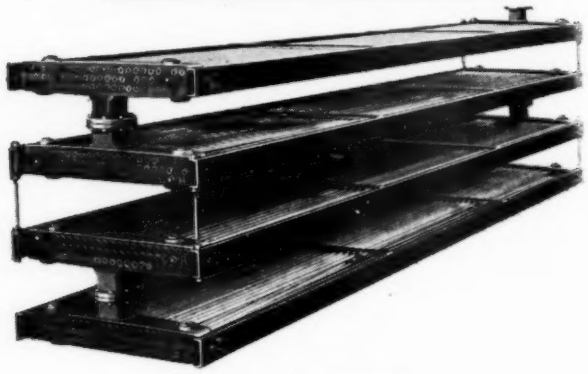
67 Wall Street, New York 5, N. Y.

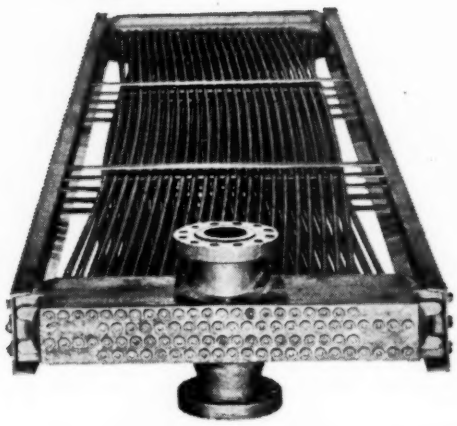
FIN-FAN EXCHANGER



A "package type" air-cooled condenser or cooler that can be installed on the ground, within a building, or on a roof, and operates independently of the direction or velocity of surrounding air currents. Upper illustration: small FIN-FAN installation operating out-doors. Lower illustration: G-R K-FIN Air-Cooled Section which provides the FIN-FAN heat transfer surface. Described in Bulletin 1231.

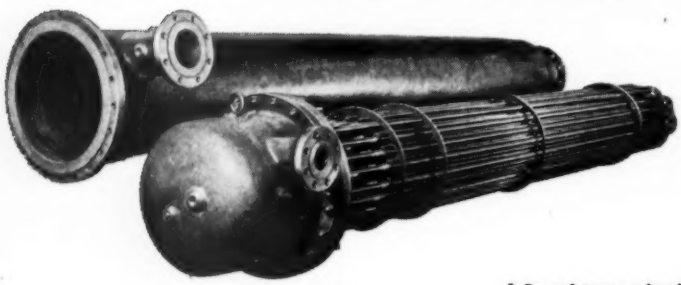
BENTUBE SECTIONS

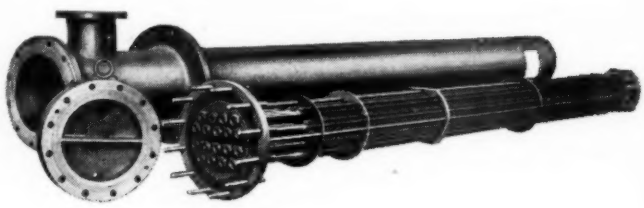




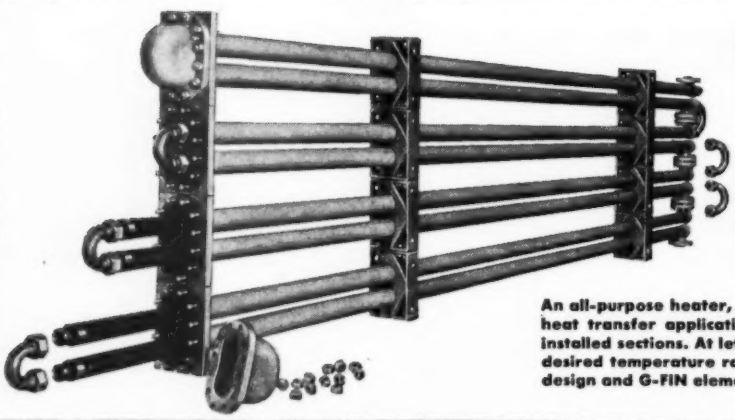
Atmospheric or submerged cooling or condensing sections with scale-shedding feature that eliminates the need for hand-scaling. Used by more than 400 refineries and natural gasoline companies. Upper illustration: stack of Bentube Sections. Lower illustration: top view of Bentube Section showing cold curvature of the Bentube elements. Described in Bulletin 1602.

G-FIN STORAGE TANK OIL HEATER

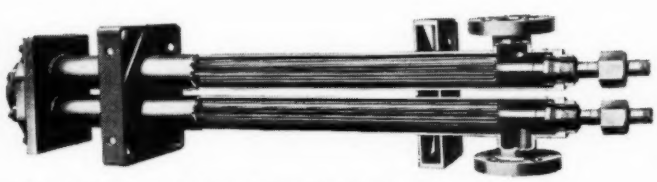




A finned-type unit with many advantages for heating viscous liquids to be withdrawn from storage tanks. At left: design for installation outside of tank. At right: design for installation partly inside of tank. Described in Bulletin 1642.



TWIN G-FIN SECTION



An all-purpose heater, cooler, condenser or heat exchanger having the widest heat transfer applications of any design on the market. More than 50,000 installed sections. At left: stack of TWIN G-FIN SECTIONS connected in series for desired temperature range. At right: cut-away view of section showing simple design and G-FIN elements. Described in Bulletin 1614.

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

Stock Units

as well as special designs in HEAT TRANSFER APPARATUS

Besides its many special designs in heat transfer apparatus, Griscom-Russell also has *standard* designs that enable you to save time required for special engineering development and manufacturing processes.

Some of these standard units are shown and briefly explained on the opposite page. They include apparatus for practically every standard heating, cooling, condensing and heat exchange service, and for many special services . . . units with bare tube and finned tube heat transfer surfaces...units for cooling or condensing with water or air . . . units for heating with steam or hot liquids. Each type has thoroughly proven its effectiveness, excellent design, and sturdy construction in thousands of installations, and is based on the Griscom-Russell 80 years of experience in specializing on heat transfer apparatus.

Write for bulletins describing in detail the units that may meet your requirements for heating, cooling, condensing or heat exchange processes. Your request for further information involves no obligation.

THE GRISCOM-RUSSELL CO.

285 MADISON AVENUE, NEW YORK 17, N. Y.

GR-220A

GRISCOM-RUSSELL

LIQUIDATION SALE!

at a FRACTION OF ITS $3,000,000 COST

CRACKING and TREATING REFINERY EQUIPMENT and MATERIAL

All Brand New!

FABRICATED PIPE
450 tons
2-inch to 24-inch

STRUCTURAL STEEL
700 tons
Beams, Channels, Angles, etc.

TUBES

100,000 feet — 2⅜ O. D. — RT seamless tubes—ASTM spec. A 83.
209,000 feet — 2⅜ O. D. — DT seamless tubes—ASTM spec. A 179.
212,000 feet — 2⅜ O. D. — KT seamless tubes—ASTM spec. A 161.
500,000 feet — 1⅞ O. D. — seamless tubes—ASTM spec. A 16.

TURBINES—STEAM

1—925 HP type TS, Terry
1—750 HP type CS, Terry
1—150 HP 2970 RPM Type G
1—65 HP 2960 RPM type DS-114
1—55 HP 2970 RPM type Z-1, Terry
4—50 HP 2960 RPM type DS-114
2—26 HP 2960 RPM type DS-114
1—24 HP 2960 RPM type DS-114
1—24 HP 1480 RPM type DS-114
1—20 HP 2960 RPM type DS-114
2—15 HP 2960 RPM type DS-114
2—9 HP 2970 RPM type DS-114
1—5 HP 2880 RPM type YL
1—2 HP 2960 RPM type DS-114

★

TANKS

2—Salt storage and pump tanks 12' O.D.x60' long with equipment and assembly parts.
1—Feed surge tank 8' O.D.x14' long.

★

ELECTRIC MOTORS

½ HP to 600 HP

★

115 CHAIN HOISTS

½-2-3-5-6-8-16 ton

PRESSURE VESSELS

18—Pressure vessels, 37'9" long x 11'5" diam, 1⅛-inch wall, Silicon fire box steel. Suitable for 250# per sq. inch pressure.

★

EJECTOR CASES

2—Air ejector cases, cracking, single element, single stage.
1—Ejector and condenser case, cracking, single element, single stage.
2—Ejector cases, salt system, cracking, single element, 2 stage.
1—Oil ejector and condenser case, treating, single element, single stage.
1—Ejector case, salt system, treating, single element, 2 stage.
2—Ejector cases, salt sampling, single element, 2 stage.

★

PUMPS

17—Transit horizontal piston pumps 8x5x12, 12x7x18, 6x4x6, 10x5x12, 6x6x18, 10x6x12, 6x5x12, also, centrifugal, rotary, reciprocating, various sizes.

TOWERS

1—Synthetic crude tower, 7'6" I. D. x 85'7" long, with fittings and spare parts.
1—Salt neutralizer tower, 10"x18"x14' long.
1—Stripping tower, vertical, 5' I.D. x 28' high.
2—Absorption towers, vertical, 8' I.D. x34' high.
1—Scrubbing Tower, vertical, 8' I.D. x 23' high.

★

HEATERS

2—Alcorn cracking heaters capable of cracking 6000 bbls. per day—32 gravity oil.
2—Alcorn treating heaters.

★

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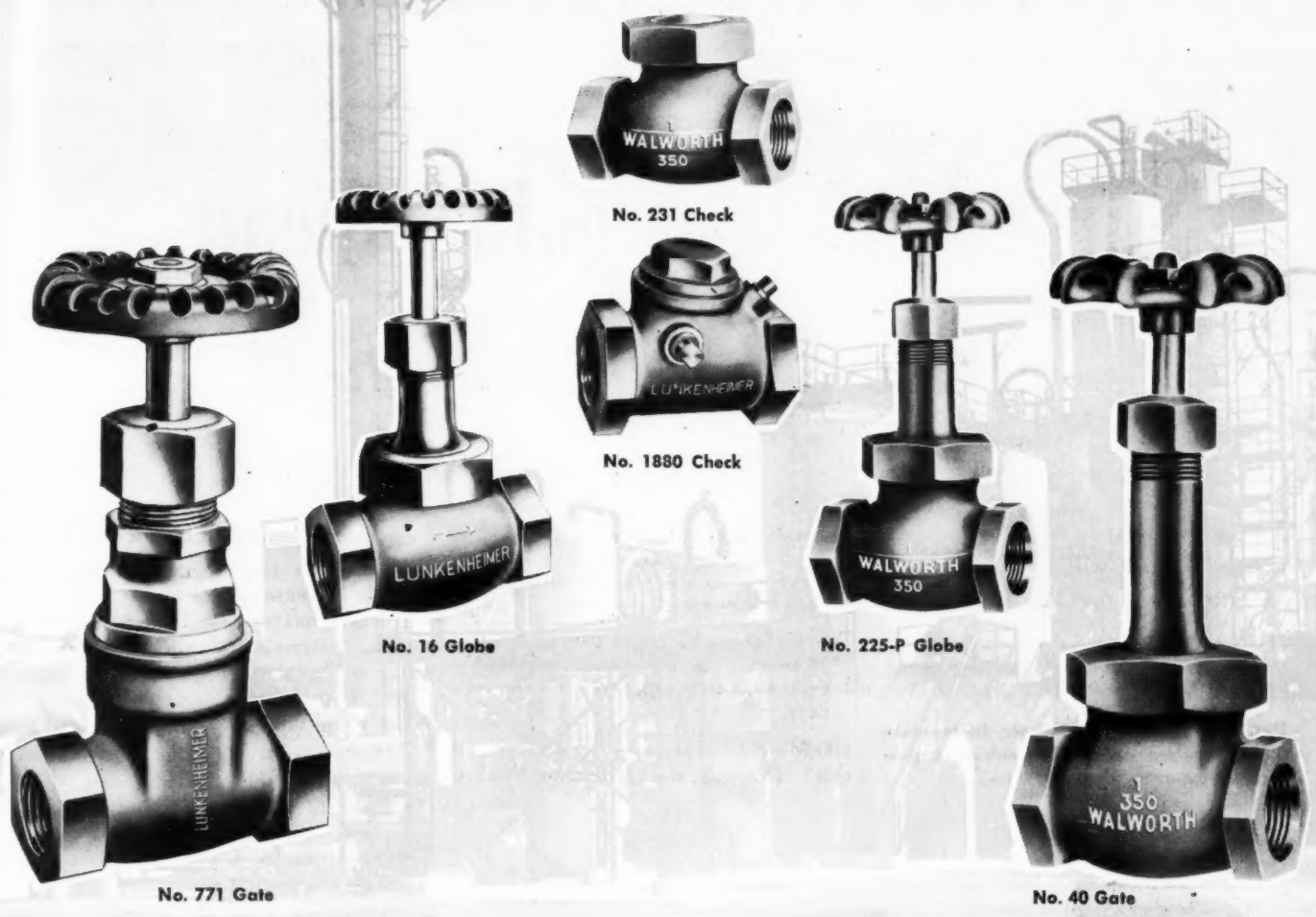

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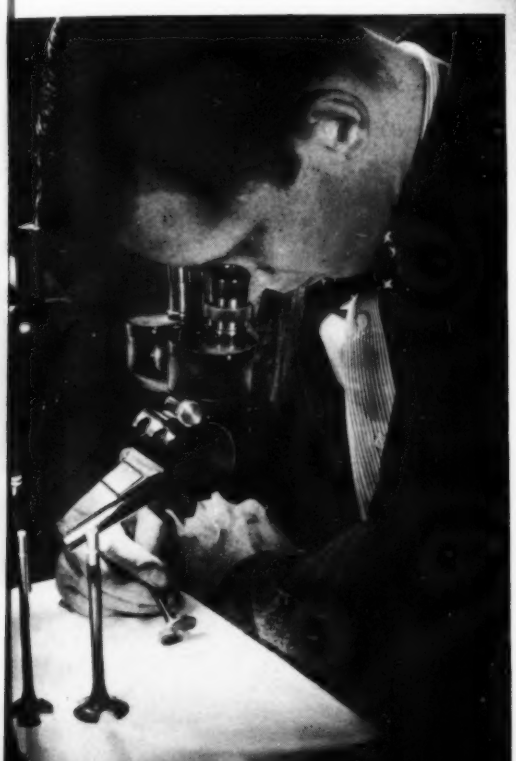

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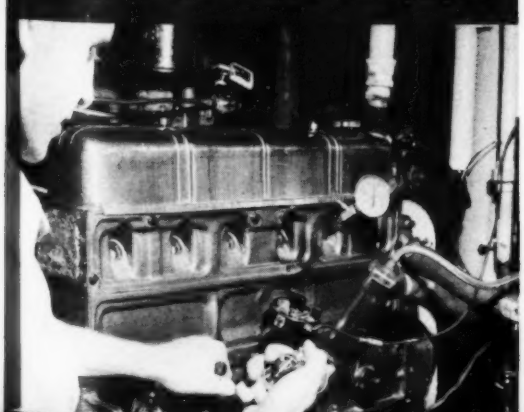

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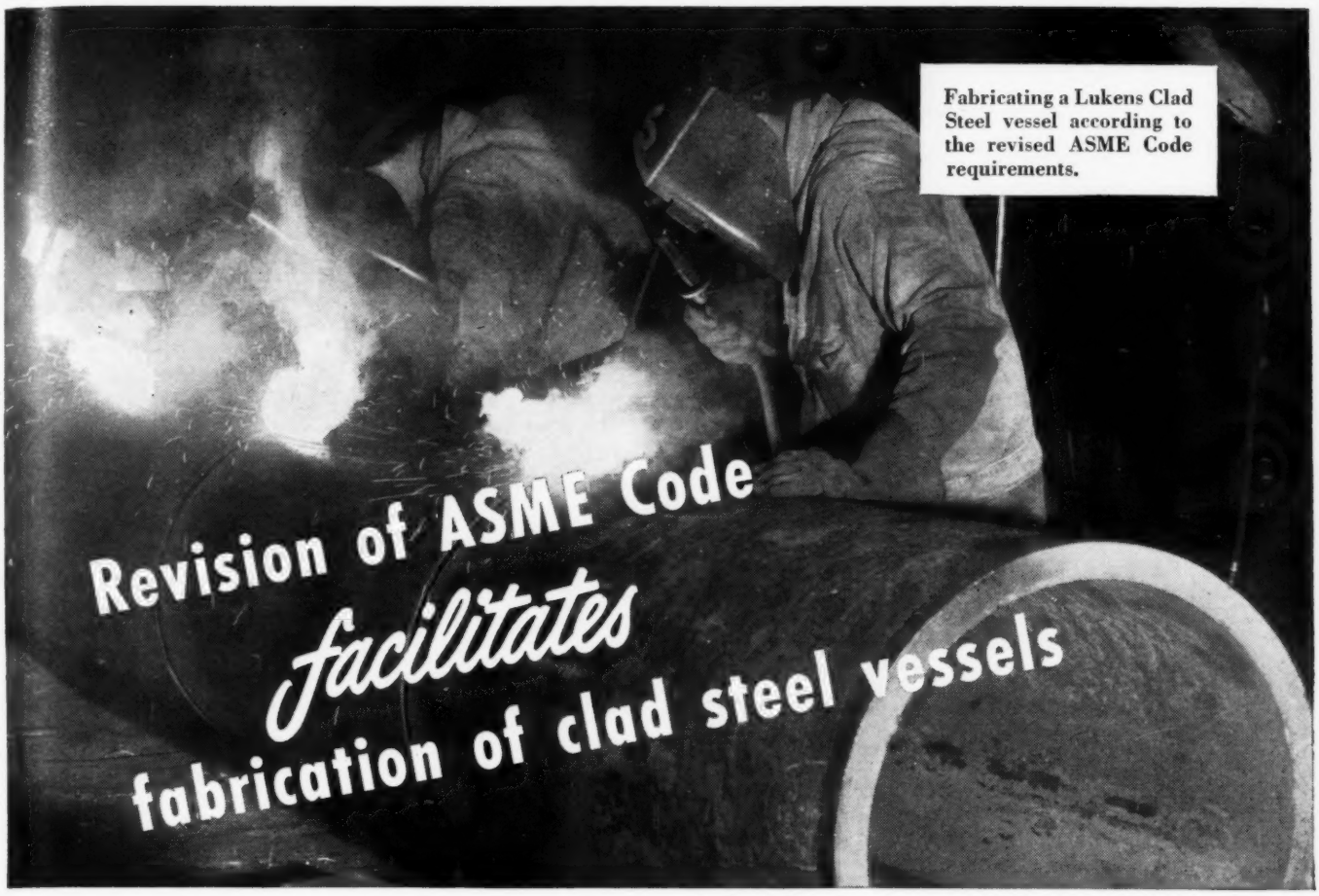

Fabricating a Lukens Clad Steel vessel according to the revised ASME Code requirements.

As announced recently in Mechanical Engineering, Case 896 of the ASME Code has been further revised. Rulings cover welding procedure and operator qualification requirements, with the result that, in many cases, the fabrication of clad steel equipment is facilitated and speeded up.

All-alloy welds can be used throughout the entire section of a clad steel shell where the small diameter, for example, makes this necessary. Materials meeting Specification SA-263, Grade A (Type 410) can be used without stress relief if the carbon content of the cladding is less than 0.08. Temperature limitations for certain types of clad metals have been modified.

Case 1078, covering the use of linings which are applicable to certain fittings—manways, nozzles and the like—is also now available for the first time.

For general information on Lukens Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad Steels, write for Bulletins 255 and 338. Lukens Steel Company, 443 Lukens Building, Coatesville, Pennsylvania.

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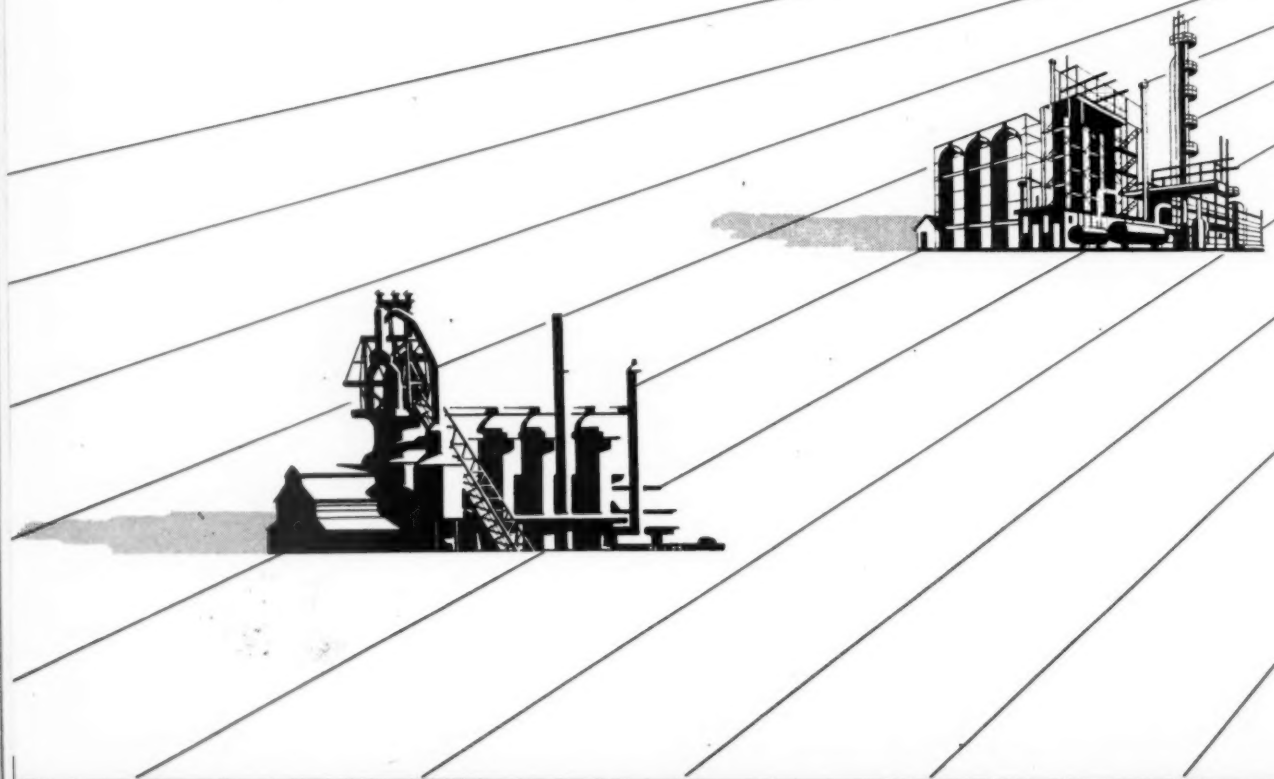

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Staff Report
On the Liquid
Fuels Program

PETROLEUM
PROCESSING
MARCH, 1949

Coal Hydrogenation Is Improved For Making Synthetic Fuels

Two new developments in the coal hydrogenation process as applied to the manufacture of synthetic liquid fuels in this country have been reported recently by the U. S. Bureau of Mines, in its Synthetic Liquid Fuels Program:

1—Technological improvements to increase efficiency and reduce costs, including principally: new processes for coal gasification in making hydrogen and better design and equipment providing larger capacity converters for the hydrogenation step.

2—Detailed engineering and cost studies, for 30,000 b/d hydrogenation plants, based on using five grades of coal found in abundance in various areas of the United States.

The official Bureau of Mines bulletins announcing these developments are reviewed below.

1-Technological Process Improvements

TECHNOLOGICAL developments in the coal hydrogenation process, worked out by the U.S. Bureau of Mines in its Synthetic Liquid Fuels Research program, will make that process an important part of the future synthetic fuels industry in this country, the Bureau reports. Coal consumption and costs, it states, are not higher basically than for the carbon monoxide-hydrogen (Fischer-Tropsch) synthesis using coal.

The improvements referred to include: 1) new pressure processes for coal gasification for manufacturing hydrogen, among other uses; 2) fully automatic control of the hydrogenation stalls, following postwar experience in Europe; and 3) special design of wrapped high pressure vessels in place of forged equipment. In the distillation of the product from the hydrogenation operation, it is said the delayed coking process will be used in place of centrifuges and flash distillation in the separation of the heavy oil from the hydrogenation residue.

In a projected hypothetical 30,000 b/d coal hydrogenation plant, operating with these and other possible improvements, the Bureau states that gasoline could be made for a net manufacturing cost of 9.3c/gal., if the returns from the sale of liquefied petroleum gas and phenols, produced as by-products, were credited to the gasoline manufacturing cost. If sales of LPG only were so credited and the phenols converted to gasoline, the manufacturing cost of the gasoline would be 13.3c/gal. See Table 1.

In both instances, cost figures are without allowing for return on the investment, sales expense, and other charges outside of plant operation.

"It seems obvious," states the Bureau reports, "that the coal-hydrogenation process will be an important part of future synthetic fuels industry. Its coal consumption and costs basically are not higher than those of a carbon monoxide-hydrogen synthesis plant using coal. The chemical nature of the coal hydro-products and their content of aromatics are valuable, not only in their utilization as fuels, but also in the field of chemicals.

"The hydrogenation process can also be used for complete conversion of heavy residues and shale oil to gasoline and other fuels. In Europe it was found on commercial scale that service factors of 90% and better were achieved. The safety of the high-pressure process, as reflected in the accident rate, was better than in atmospheric pressure gasification or distillation plants. Because better construction materials are available in this country, a further improved performance can be expected."

Actual commercial installations for making synthetic fuels from coal may include both the hydrogenation process and the Fischer-Tropsch gas synthesis, the Mines Bureau technologists believe, for two reasons. First, the two processes are complementary, as far as quality of products is concerned. Products from high pressure coal hydrogenation are aromatic and naphthenic, but are saturated and stable, while those from carbon monoxide-hydrogen synthesis are mainly paraffins and olefins.

Gasoline from coal hydrogenation has a high octane number and an excellent rich-mixture performance, it is stated, combined with good gum and storage stability. It is suitable for aviation gasoline or base stock. Diesel fuel from coal hydrogenation can be given a cetane number of 45 or higher. Both Diesel and jet fuels have low pour and freezing points.

TABLE 1 — Manufacturing Costs for Gasoline in Hypothetical 30,000 b/d Coal Hydrogenation Plant

Debits	c per Gal. Gasoline
Coal at $3.56 per ton	4.8
Labor ($1.75 per hr.) and supervision	1.3
Maintenance	2.1
Overhead, supplies and indirect costs	3.2
Amortization, 15 years	4.8
Taxes (1 per cent)	0.7
Subtotal	16.9
Credits	
LPG at 8c per gal.	2.6
Phenols at 10c per lb.	5.0
Total net costs	9.3
Credit for LPG only, phenols converted to gasoline	13.3

TABLE 2—Data of Bituminous-Coal Hydrogenation Products Obtained in Experimental Units

Characteristic	Motor Gasoline	Aviation Gasoline	Jet Fuel	Diesel Fuel
Deg. API	51	54	35	32
Boiling range, ° F.	95–350	105–320	320–570	350–600
Aromatics, %	45	43	..	..
Naphthenes, %	35	35	..	..
Paraffins, %	18	20	..	..
Olefins, %	2	2	Below 3	Below 3
Sulfur, %	Below 0.05	Below 0.02	Below 0.1	Below 0.1
Octane No. MM	78	80	..	..
Oct. No. MM +3 ml. TEL.	90	94	..	..
Cetane No.	..	..	..	45
Reid Vapor Press. psi.	10	7	Below 2	Below 2
Freezing point, ° F.	Below —76	Below —76	Below —76	Below —40

Coal hydrogenation also is said to be suitable for production of fuel oil.

By-products from coal hydrogenation include phenols and aromatics, such as benzene, toluene, xylenes and solvents, as well as polynuclear aromatics. Off-gases formed during the process are mainly saturated and have a high content of isocompounds, such as isobutane and isopentane.

On the other hand, products from the Fischer-Tropsch synthesis, being mainly paraffins and olefins, have a negligible content of ring compounds. The oxygen-containing by-products are aliphatic alcohols, aldehydes, ketones and acids. The off-gases are rich in olefins and have only a small content of isocompounds.

Combination Raises Efficiency

A second reason for the coal hydrogenation and Fischer - Tropsch processes being complementary is said to lie in the fact that, in several phases of both, such as gas production, power generation,off-gas utilization and so on, a combination would work towards increased efficiency and lower cost operation in each instance.

The Bureau's actual work on the two coal synthesis processes to date has been confined to laboratory studies and small-scale experiments.

However, as part of its program, two coal-to-oil demonstration plants are being built at Louisiana, Mo., on the site of a wartime synthetic ammonia works made available by the Army Quartermaster General. The hydrogenation plant, built under contract by Bechtel Corp., is said to be essentially complete and ready for operation. It is designed for operation up to 10,000 psi. in two steps; liquid-phase hydrogenation, which accomplishes the liquefaction of the coal, and vapor-phase hydrogenation, which converts the liquefied coal to gasoline and by-products. Depending on the coal and catalyst used, the output of the plant will vary from 200 to 300 b/d.

Early in 1948, contract was let to the Koppers Co. for design and construction of a $4,500,000 gas synthesis demonstration plant, a 100 b/d unit which will gasify pulverized coal with oxygen and superheated steam, purify the gas and convert it to liquid fuels by a modified Fischer-Tropsch synthesis process.

In its current report on its studies on the coal hydrogenation process, the Bureau stated that a plant to produce about 30,000 b/d of gasoline and LPG will consist of large units to permit low labor costs. It will also contain several of these units in different stages of operation, so that continuous plant production could be maintained. Such a plant would consist of four sections:

1—Hydrogen production and compression.

2—Hydrogenation proper.

3—Product distillation.

4—Power and utilities production and distribution.

"For the production of hydrogen in the 30,000 b/d plant, coal gasification with oxygen and the methane-steam process for converting excess off-gases are provided," states the Bureau's report. "Hydrogen production with compression as the largest power consumer, determines to a great extent the power requirements and the thermal efficiency of the process. It may be mentioned that the power plant, including the process and heating-steam production, has about 40% thermal efficiency, the lowest of all the plant sections.

"It is, therefore, important to note that new processes for gasification under a pressure of about 300 psi. are being developed which cut the compression costs and increase the thermal efficiency. These pressure gasification processes are still in the experimental stage; but they are needed for the hydrogenation process, as well as the carbon monoxide-hydrogen synthesis, and their development to commercial operation is only a question of time.

"The design of the hydrogenation proper plant also must be aimed toward a reduction in plant costs and increase in thermal efficiency. By using large converters of 700-cu. ft. volume—twice the size of the converters used commercially in Europe—not only the construction, but also the operating costs were decreased.

"A further increase in capacity per unit and in yield will be possible owing to complete automatic control of the hydrogenation stalls. The latest European experience in this field showed very significant improvements due to smoother operation of automatically controlled stalls.

"A decrease in equipment costs was also achieved by using wrapped high-pressure vessels. These vessels were developed in Germany about 10 years ago and are cheaper and stronger than forged vessels. They consist of interlocked ribbons, wound hot, with the proper stress, around a core tube.

"Further improvements in the high-pressure section were achieved by careful selection of construction materials, an elaborate heat exchange and utilization of the heat of reaction to preheat the feed in a preheat converter, simpler steam-driven paste pumps, and cheaper construction of the cooler.

"For distillation of products and recovery of liquefied petroleum gas, modern refinery practice was followed. An important part of the hydrogenation process is also separation of heavy oil from the hydrogenation residue. Instead of the centrifuges and flash distillation hitherto used, the delayed coking process was chosen, which promises high yields of oil at low costs.

"The newest process development for a single-stage operation at 10,000 psi. was selected for the vapor-phase part of the plant. The catalyst for this operation is cheap and has long life: German commercial experience showed about one year. The gasoline made with this catalyst is high in aromatics and octane number as shown in Table 2. Experiments have indicated that further improvements in octane number are possible. The conversion of the middle oil to gasoline to gasoline per pass is 50%. Complete middle-oil conversion is obtained by recycling the unconverted middle oil. The yield of finished gasoline is 100% by volume.

Liquid Products

".The plant for hydrogenation of a low-ash, high-volatile bituminous coal is designed to produce the following volumes of liquid products: gasoline, 22,100 b/d; liquefied petroleum gas, 7250 b/d; phenol, cresols and xylenols, 1330 b/d; total, 30,680 b/d. Corresponding to 2.5 bbls. product per ton of coal, coal consumption would be 12,500 tons per day."

The general description of the coal hydrogenation process, as contained in the same Bureau of Mines report, follows:

"The high-pressure hydrogenation of coal, as Fig. 1 shows, is normally performed in two stages. The first is the conversion of coal, made to a paste in the so-called liquid phase with a finely divided catalyst, to a middle oil. This middle oil then is converted over a solid catalyst in va-

por phase to gasoline, jet, or Diesel fuel. Products of the liquid phase can be used as fuel oil; due to their content of phenols and nitrogen compounds, however, a finishing by vapor-phase hydrogenation is necessary if gasoline, jet fuel, or Diesel fuel is produced.

"The vapor-phase catalyst performs conversion of this middle oil to a stable, sulfur-free, final product of the desired boiling range and hydrogen content. For liquid-phase hydrogenation the coal is de-ashed, if necessary, and is ground and made to a paste with catalyst and recycled heavy oil. The paste, containing about 50% coal, is brought to 10,000 psi pressure with feed pumps and joins the hydrogen stream, consisting of make-up and recycled hydrogen.

"The mixture of hydrogen and paste is preheated by heat exchange and gas-fired preheaters nearly to reaction temperature, then enters several converters in series. In the first converter, because of the heat of reaction, the temperature rises to a reaction temperature of about 900° F. and is held down to that level by the admission of cold recycle gas.

"The reaction products, having passed the converters, enter the so-called 'hot catchpot'. The heaviest oil fractions and asphalt, together with ash, catalyst, and about 1 to 4% of unconverted coal, are withdrawn at the bottom and discharged by means of special let-down valves. This slurry, the so-called 'H.O.L.D.', goes to the oil-recovery plant. The recovered oil is recycled to the coal-pasting plant. The hydrogen and oil vapors from the hot catchpot are used to preheat the feed in heat exchangers and then cooled and separated from the hydrogen in the cold catchpot.

"The hydrogen goes to an oil scrubber to remove inerts and gaseous hydrocarbons formed in the process and then is returned to the start of the process by booster compressors. The condensed oil is let down from the cold catchpot and distilled into an overhead middle-oil fraction with about 620° F. end point, and bottoms. The bottoms are used as pasting oil. The liquid-phase middle oil contains about 15% tar acids. They can be recovered and are a very valuable byproduct. About 8% by weight of the finished gasoline is phenol, cresols, and xylenols.

"The middle oil is injected to the vapor phase. The flow in the vapor-phase unit is similar to that from the liquid phase, but this phase contains no hot catchpot. The main difference is that the converters are filled with solid lump catalyst, and the oil passing over the catalyst is evaporated in the hydrogen stream. The products of the vapor phase are distilled in a conventional way into gasoline and unconverted middle oil. The middle oil is recycled into the vapor phase and converted to gasoline.

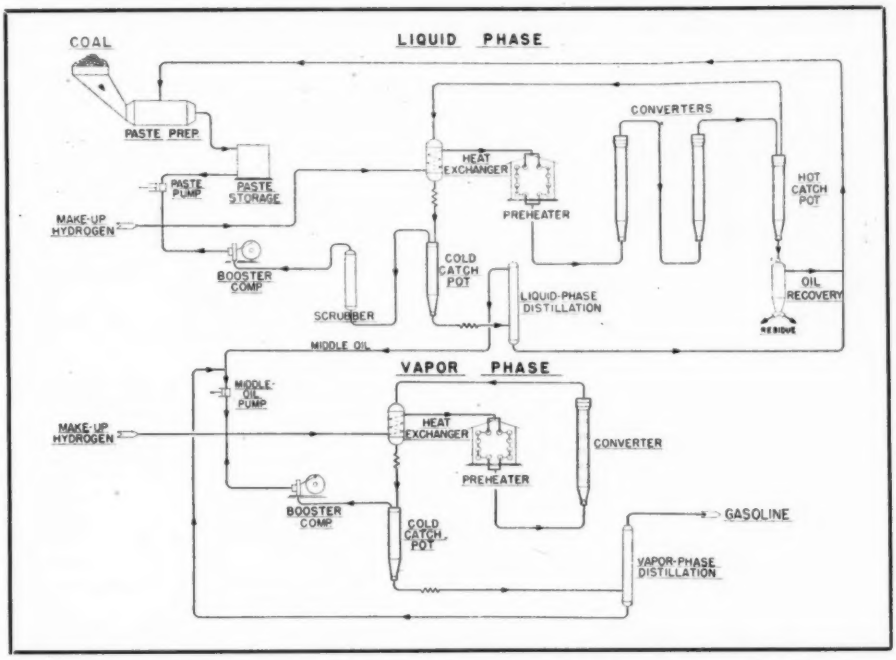


Fig. 1—Flow diagram for the high-pressure hydrogenation of coal

References

This article is a review of Bureau of Mines Information Circular 7486, "Improvements in Hydrogenation of Coal, by L. L. Hirst, Chief, Coal to Oil Demonstration Branch, Office of Synthetic Liquid Fuels, Louisiana, Mo.; L. C. Skinner, Chief, Engineering and Design Section, Coal to Oil Demonstration Branch, Office of Synthetic Liquid Fuels, Louisiana, Mo.; and Dr. E. E. Donath, formerly chief chemist for research, Hydrogenation Department, I. G. Farbenindustrie, Ludwigshafen am Rhein, Germany.

Copies may be obtained by writing the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

2-Cost Data from Engineering Study

DETAILED engineering studies and cost estimates for commercial coal hydrogenation plants, as made by the Bureau of Mines, were presented in the 1948 Annual Report on Synthetic Liquid Fuels of Secretary of the Interior Krug. Process developments reviewed in the preceding article are incorporated in these estimates.

In its investigations of the possibilities of commercial production of synthetic fuels by hydrogenation, the Bureau staff had the aid of German technical personnel with years of experience in the field. The Bechtel Corp., refinery engineers with headquarters on the West Coast was engaged by the Bureau to prepare detailed preliminary designs and estimates of the cost of a hydrogenation plant to produce 30,000 b/d of liquid products. This capacity was selected to obtain maximum savings in capital and operating cost. By comparison, it is said to be about 60% greater than the yearly production of the largest German hydrogenation plant, and about equal to the size of largest German plant ever planned.

To cover comprehensively the coals suited for the process, five coals were selected which are representative of large deposits found in this country. Basic calculations were made using Wyoming bituminous coal, because this coal is regarded as very suitable for hydrogenation and it also is fairly representative of large coal deposits in Colorado, Wyoming, and Utah. North Dakota lignite is representative of that type of fuel occurring in large quantities in that state and in Montana.

Montana sub-bituminous coal represents another type of solid fuel found in large deposits which can be mined at low costs. Illinois bituminous coal is representative of the high-volatile bituminous coals found in the mid-western area, including Indiana and western Kentucky. Pittsburgh-seam coal is reasonably typical of large deposits in Pennsylvania, West Virginia, eastern Kentucky, and Alabama. Care was

TABLE 1—Estimated Coal Consumption and Volume of Final Products for Coal Hydrogenation Plants

Coal Coal consumption	Wyoming bitum.	N. Dak. lignite	Mont. sub-bitum.	Illinois bitum.	Pitts.-seam bitum.
Run-of-mine coal, tons/day	11,830	22,200	16,550	13,120	10,760
Moisture- and ash-free coal, tons/day	9,980	12,420	11,130	10,090	9,500
Production					
Gasoline, b/d	21,660	22,500	22,360	21,630	20,250
LPG, b/d	7,100	6,260	6,400	7,130	8,510
Phenols, b/d	1,240	1,240	1,240	1,240	1,240
Phenols, lb/d	(450,000)	(450,000)	(450,000)	(450,000)	(450,000)
Totals, b/d	30,000	30,000	30,000	30,000	30,000

TABLE 2—Cost Estimates for 30,000 b/d Coal Hydrogenation Plants

(Figures in Thousands of Dollars)

Coal	Wyoming bitum.	N. Dak. lignite	Mont. sub-bitum.	Illinois bitum.	Pitts.-seam bitum.
Hydrogenation Section	97,292	96,865	98,635	99,625	106,805
Gas-Production Section	54,749	60,074	57,710	53,204	54,750
General and auxiliary Plants Section.	90,879	98,303	97,678	93,974	96,265
Total, $1000	242,920	255,242	254,023	246,803	257,820
Dollars/bbl./day	8,097	8,508	8,467	8,227	8,594
Field labor, 1000 man-hours	21,736	22,968	22,733	22,013	22,803
Steel, tons	158,000	165,000	164,000	159,000	167,000

TABLE 3—Manufacturing Costs for Coal Hydrogenation Plants

Coal	Wyoming bitum.	N. Dak. lignite	Mont. sub-bitum.	Illinois bitum.	Pitts.-seam bitum.
Coal as mined, $/ton	3.56	1.85	1.10	3.12	4.02
Personnel required	3,200	3,360	3,345	3,250	3,385
Daily costs 30,000 B/D Liquid Products					
Coal	$42,111	$41,066	$18,162	$40,925	$43,243
Other materials	17,156	18,103	18,212	17,443	19,286
Other direct costs	28,177	29,591	29,462	28,636	29,913
Indirect costs	17,847	18,746	18,662	18,136	18,945
Fixed costs	51,020	53,613	53,357	51,840	54,154
Total	$156,311	$161,119	$137,855	$156,980	$165,541
Credit for LPG at $0.08/gal.	23,856	21,034	21,504	23,957	28,594
Net cost gasoline (without recovery of phenols)	$132,455	$140,085	$116,351	$133,023	$136,947
Unit costs, $/gal. gasoline	0.14	0.14	0.12	0.14	0.15

taken not to use coals suitable for coking. Table 1 summarizes the estimates of coal consumption and products obtained.

The requirements selected for the products were that the gasoline be a high-grade, anti-knock motor fuel, below 0.01% in sulfur content, and higher in aromatics and Btu. per gallon than gasolines obtained from crude oil. The octane number was 78 (Motor Method unleaded) for bituminous coal as raw material and somewhat lower for the other coals.

The phenols produced as by-products were estimated to contain about 20% carbolic acid, 35% cresols and 45% xylenols. The composition of the liquefied petroleum gases is estimated to be about 3% ethane, 65% propane and 32% butane. The estimated capital costs for the five plants operating on the selected types of coal are shown in Table 2.

The table shows also the estimated man-hours of field labor and the total steel requirements. Steel required per daily barrel of capacity is 5.3 to 5.6 tons. The figures given do not include the development of mines, employe housing, or rail and pipeline facilities for the movement of raw materials and finished products. Total investment is between $8100 and $8700 per daily barrel of liquid products.

Based on the capital costs, product quantities and coal consumption as given in Tables 1 and 2, the manufacturing costs given in Table 3 were obtained. Coal prices were taken from the 1946 Bureau of Mines Mineral Market Report, with 10% added to approximate current costs.

These estimates allow 3% of the total investment for maintenance and 6.67% (15 years) for amortization. For operating labor an average rate of $1.75 per hour was taken. The gasoline manufacturing costs obtained were 12 to 15c per gal., crediting LPG at 8c per gal. The cost differences are due to variation in coal prices as well as to different suitability of the various coals for the process. If phenols are recorded to the extent of 450,000 lbs. per day and credited at 10c per lb., the cost of gasoline is reduced by 4c per gal. giving net costs ranging from 8 to 11c per gal.

Due to the versatility of the coal hydrogenation plants as projected, they could be used without change for the production of aviation gasoline base stock, which could be manufactured at about the same cost and in the same quantities as motor gasoline. For the production of alkylate from the liquefied petroleum gases, additional dehydrogenation and alkylation equipment would be necessary.

TABLE 4—Production of Jet Fuels by Coal Hydrogenation

Product	Jet Fuels JP-1	Jet Fuels JP-3
Jet fuel, b/d	18,000	24,000
Motor gasoline, b/d	6,000	.....
LPG, b/d	4,750	4,750
Phenols, b/d	1,250	1,250
Totals, b/d	30,000	30,000

The projected hydrogenation plants could also be used for the production of jet fuels by a minor change—replacement of the vapor-phase catalyst. The jet fuels would meet the current required specifications and, if required, oils of higher specific gravity and heating value per gallon could be obtained. In making jet fuel according to proposed Specification JP-3, gasoline could be blended into the jet fuel. In such a case the manufacturing costs would be somewhat lower than those for gasoline. Some of the equipment necessary for gasoline production in the vapor-phase and distillation stages would be idle or eliminated altogether if only jet fuels were required. Diesel fuels having a cetane number from 40 to 50 could be produced in the same quantity as jet fuels. The cetane number could be increased by using a special catalyst. Table 4 gives the estimated production for the two grades of jet fuels.

Heavy Fuel Oils

The short supply of a year ago in heavy fuel oil, in the heavy industry area of the eastern U.S., stimulated the study of finding supplemental sources of this product. The heavy industry areas have access to large deposits of high-volatile bituminous coal that can be converted into oil that will burn readily in existing equipment. Therefore, at the suggestion of some large consumers of heavy fuel oil, a study was made by the Bureau of Mines of the possible methods for converting coal to heavy fuel oil.

Two basic processes were selected. The first was direct hydrogenation of coal at 700 atm. (10,300 psi.), to produce fuel oil, with gasoline, phenols and liquefied petroleum gases as by-products. The second was a combination process involving hydrogenation at 700 atm. to produce a solvent oil for an extraction operation at 150 atm., (2200 psi.) to make fuel oil. Gasoline, phenols and LPG again were by-products.

A heavy Illinois high-volatile coal was selected. The basic projected plant was to produce 10,000 bbls. of fuel oil per calendar day. For construction and operating cost estimates, each plant was considered, first, as having no source of hydrogen except that which could be obtained by cracking the gases produced by the process and from the gasification of coal; second, as having an adequate supply of coke-oven gas available to supply the makeup hydrogen requirements over and above that re-

covered from the off-gases by low-temperature separation.

Insofar as original costs and operating expenses are concerned, the projected plant was limited to actual processing equipment and auxiliaries, such as hydrogen production, fuel-gas production and storage. Steam and electric power generating equipment were excluded as being outside the scope of the investigation.

The plant costs include not only the equipment but also foundations, supports, buildings, piping, instruments, electrical installations and miscellaneous items. Cost of plant utilities and general plant facilities is included, except for power and steam-generating capacity, which was assumed to be purchased from outside sources. Administrative overhead and similar costs were added as percentages of direct costs. A summary of plant costs for the two types of coal hydrogenation plants to produce fuel oil are given in Table 5.

Operating costs as set up for this type of hydrogenation plant include direct, indirect and fixed costs, with plant amortization set at 15 years. Credit was taken for by-product gasoline, LPG, phenols, combustible residue and tail gas, where a surplus was available. It was determined that cost of fuel oil from plants of this size would range from \$3.07 to \$4.16 per bbl. at the plant, with coal at \$3 per ton. With freight costs of \$1.90 per ton for coal or \$0.85 per bbl. for oil added, the cost without profit at the point of consumption would range from \$4.35 to \$5.04 per bbl.

TABLE 5—Comparison of Estimated Plant Costs and Volume of Products, for Fuel Oil Coal Hydrogenation Plants

(Cost figures in Thousands of Dollars)

Type of plant	Hydrogenation		Hydrogenation-extraction	
Source of hydrogen	Coal gasification	Coke-Oven gas	Coal gasification	Coke-oven gas
Coal and paste prep. \$1000	5,223	4,972	5,351	5,196
Hydrogenation, \$1000	30,110	30,110	29,562	29,562
Extraction, \$1000	.....	.....	6,784	6,784
Gas supply, \$1000	16,905	11,829	19,337	14,249
Utility and storage, \$1000	12,154	11,035	14,100	12,998
Total plant cost, \$1000	64,392	57,946	75,153	68,789
Fuel oil, b/d	.....	10,000	.....	10,000
Gasoline, b/d	.....	1,001	.....	1,464
LPG, b/d	.....	890	.....	1,300
Phenols, b/d	.....	159	.....	304
Residue, tons/day	.....	372	.....	710
High-ash coal, tons/day	1,966	2,904	1,882	2,782
Coal required:				
Coal as mined, tons/day	.....	6,575	.....	6,631

While these costs do not allow synthetic fuel oil to show up in a favorable light, it is predicted that they would be lowered by technological improvements which will be available before a commercial-size plant for the production of fuel oil from coal could be designed and built. With such improvements included, it is concluded that a saving of at least 10% in investment and operating costs is possible in plants using coke-oven gas as the primary source of hydrogen. In plants depending upon coal gasification as the principal source of hydrogen, savings up to 20% are considered possible. If these process improvements were incorporated in a 30,000 b/d capacity plant, it is estimated that fuel oil made from coal could be delivered within a 150-mile radius for as low as \$3.10 per bbl., based on \$3 coal and without profit.

References

This article is a review of the Synthetic Liquid Fuels 1948 Annual Report of the Secretary of the Interior, Part 1—Oil from Coal. The report has been published as three separate publications, with the respective titles:

Report of Investigations 4456, Part I—Oil from Coal

R.I. 4457, Part II—Oil from Oil Shale

R.I. 4458, Part III—Liquid Fuels from Agricultural Residues, and Part IV—Secondary Recovery and Petroleum Chemistry and Refining Research.

Copies of the publications can be obtained by writing Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

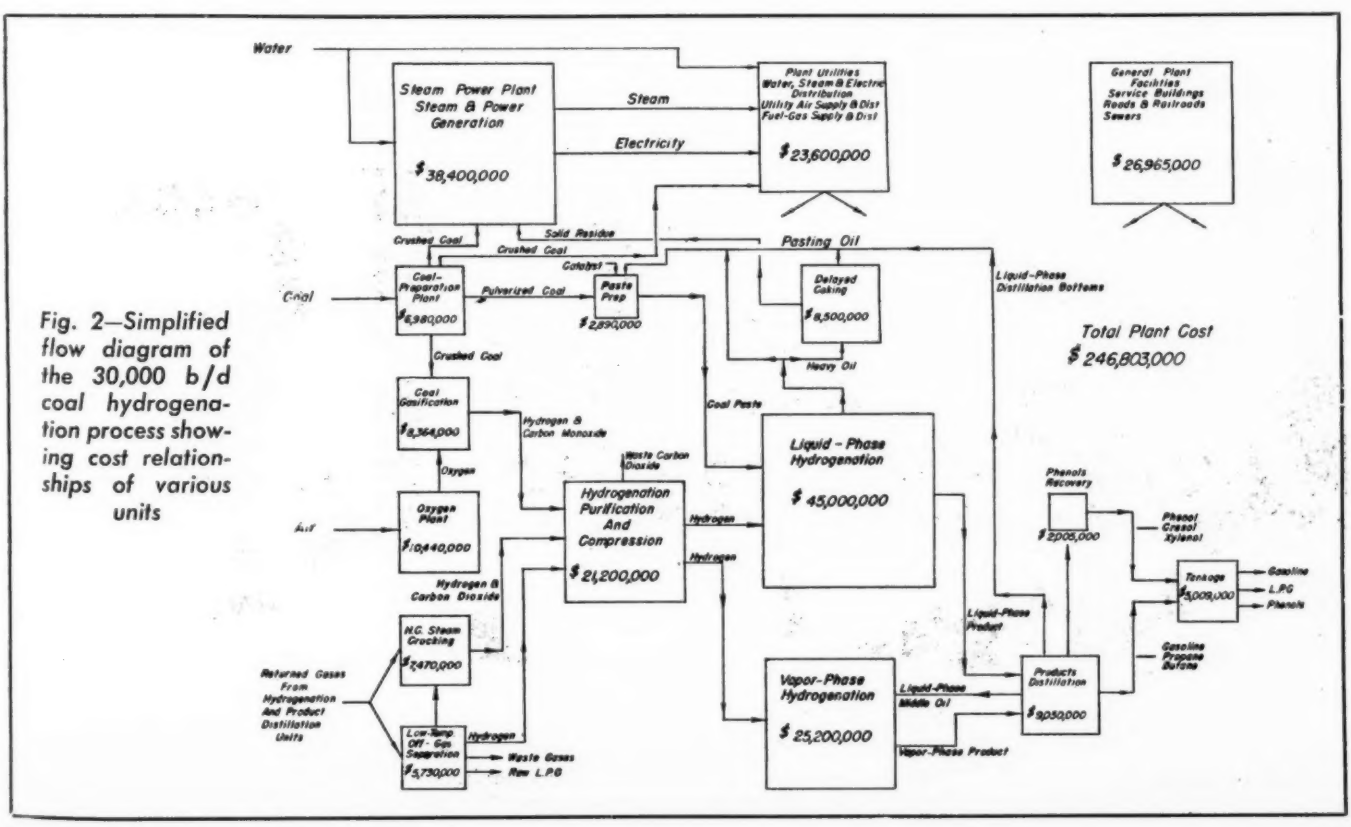


Fig. 2—Simplified flow diagram of the 30,000 b/d coal hydrogenation process showing cost relationships of various units

Planning of Plant Maintenance Topic for API Refining Meeting

A DISCUSSION OF ADMINISTRATIVE PROBLEMS in connection with refinery maintenance will be a feature of the program of the Mid-Year Meeting of the Refining Division of the American Petroleum Institute, at Houston, April fourth to seventh.

This Group Session, April 7, will include papers on the scheduling of work, allocation of manpower, use of labor-saving devices and other subjects of importance to plant management. Elliott B. McConnell, vice president for manufacturing, Standard Oil Co. (Ohio) will preside at this meeting.

In planning this session, the program committee took into account that the great majority of meeting papers heretofore have been devoted to processing methods and operations and very little to maintenance of units, repair of equipment and similar administrative functions. However, maintenance is becoming an increasingly larger factor in plant costs and special problems are involved due to the complexity and size of modern processing units. These and other topics will be included in the program for this group session.

At the group session on Waste Disposal, April 7, recent legislation on this subject will be reviewed and new developments in methods for disposal of refinery wastes will be presented, among other subjects. C. E. Davis, New York, Shell Oil Co., Inc., will preside at this session.

A group session on Rapid Methods of Analysis will be included in the Mid-Year program and is scheduled for April 5. Presiding at this session will be J. B. Rather, Jr., Socony-Vacuum Oil Co., Inc., and W. D. Seyfried, Humble Oil & Refining Co. A group of papers will present new short-cut procedures and analytical methods which have been worked out in oil company laboratories and have proved as acceptable as conventional methods for certain applications.

Another important meeting will be devoted to refinery training programs. New features of programs in use in plants will be discussed and the Committee on Refinery Training of the Refining Division will report on its work, including the survey of training programs used by the oil companies, which has been conducted at the University of Texas as an API research project.

The Refining Division's Automotive Research Committee, under the chairmanship of D. B. Barnard, Standard Oil Co. (Indiana) is sponsoring a group meeting on problems pertinent to the utilization of automotive fuels.

An important part of the work at the Mid-Year meeting will be the work of the various groups of the Refining Division on equipment, operating problems and other subjects.

Chester F. Smith, New York, Standard Oil Co. (New Jersey) Vice President for Refining, American Petroleum Institute

Meetings of committees and subcommittees as scheduled by subjects include: Unfired Pressure Vessels, Valves, Safety and Relief Valves, Emulsions, Oil Water Separation, Sludges and Spent Clays, Atmospheric Pollution, Mechanical Equipment, Tank Accessories and Cleanouts, Refinery Inspection Supervisors, Pressure-Relieving Systems, Electrical Equipment, Chemical Wastes, Instruments, Corrosion, Sampling and Testing Wastes, Refinery Equipment.

Left to right: W. T. Gunn, New York, Director, API Division of Refining; K. G. Mackenzie, New York, The Texas Co., Chairman of the Program Committee for the Mid-Year Meeting; Elliott B. McConnell, Cleveland, Standard Oil Co. (Ohio) presiding at the Group Session on Refinery Management; C. E. Davis, New York, Shell Oil Co., Inc., presiding at the Group Session on Waste Disposal.

EVAPORATION LOSSES CUT

Rapid Pay-off in Saving Vapors

Two-year Record of Liquid Movement in Illinois Refinery Gasoline Blending Tank Installation Shows Conservation Of 50,000 bbls. of Product during First Year's Operation

By WILLIAM C. UHL
Equipment Editor

SUBSTANTIAL REDUCTION OF EVAPORATION losses from a gasoline blending installation has been achieved through the use of a gasholder type, vapor-saving unit, according to complete records of a midwestern refiner. The savings in product effected a prompt pay-off of the initial investment for the equipment, it was reported by engineers of Globe Oil & Refining Co., at whose Lemont, Ill., refinery the equipment was installed.

Manifolded to six, cone roof, 25,000-bbl. tanks in gasoline blending service, a Wiggins Dry Seal Gasholder of 150,000 cu. ft. capacity was placed in operation in November, 1947, at Globe's plant. A detailed account of liquid movement through the blending system was kept by Globe engineers for one-year periods both preceding and following the installation. This showed that the original cost of the unit had been met within about two month's operation by savings in evaporation losses.

The total capital investment of the installation was $38,333; additional annual costs for taxes and insurance, maintenance, and operating expenses were estimated at about $2000. Globe saved approximately 2,000,000 gallons of gasoline in the year November 1947-48, through the use of the vapor-saving equipment, as compared with its former type of operation, its engineers estimated. Using an arbitrary figure of 11c/gal. for the gasoline saved, Globe's record indicates the monetary saving was well over $200,000. Gross gasoline production of the refiners for the period was close to 200,000,000 gals.

The installation at Lemont, designed and erected by General American Transportation Co., follows the basic principles developed in patents held by John H. Wiggins, licensor to General American. Known as a vapor-balancing system, the heart of the equipment is a dry seal type gasholder, 69 ft. in diameter by 42 ft. in height.

In operation, the mixture of air and petroleum vapors, forced from the blending tanks by heat expansion, or by "in-pumping", flows from the tanks through relatively large diameter vapor lines at low pressure to the gasholder. Reverse flow takes place when the vapor contracts on cooling, or during "out-pumping." No vapor is lost through breathing, no outside air is sucked in, and all gasoline is retained in the system.

The action of the gasholder itself simulates that of a weightless, frictionless piston moving in an open end cylinder. The unit is illustrated in Fig. 1 and in the cutaway drawing. The piston is so counterbalanced that it will move up and down within the gasholder shell at very low pressure differentials—plus or minus ¼ in. of water. The only resistance to the movement of the piston is the inherent resistance of the counterbalancing system, which is kept to a minimum.

The annular space between the piston and the tank shell, as well as that between the piston and center column support, is closed off by a gas tight, flexible fabric seal, composed of woven asbestos-glass material, impregnated and coated with synthetic rubber.

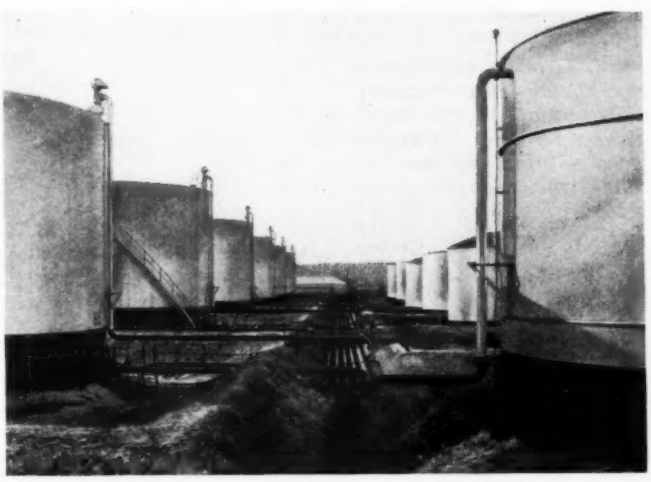
The proofing material is calendered (rolled) into the fabric to create a homogeneous impregnation tightly locked into, and between, all strands and fibers. The coatings are calendered likewise to form a tight bond and to give uniform thickness. The stock is cured to develop the needed properties of toughness, abrasion resistance, and tensile strength.

The two fabric curtains are kept relatively taut and free of wrinkles by a spirally wound wire coil formed around a center rod, which in turn is formed into a ring resting in, and rolling with, the seal loop. Tests have shown the seal material to retain its original qualities after as long as 12 years' service.

The piston itself is a metal dia-

This Month's Cover Picture

The gasholder type, vapor-saving equipment at Globe Oil & Refining Co.'s Lemont, Ill., refinery, shown on this month's PETROLEUM PROCESSING cover, was put into service late in 1947. It paid for itself in about two months, according to a complete record kept by Globe engineers, both for one year preceding and for one year following the installation. The piston-type gasholder, in the right foreground, is connected by a manifold of large diameter vapor lines to the six gasoline blending tanks seen on the left



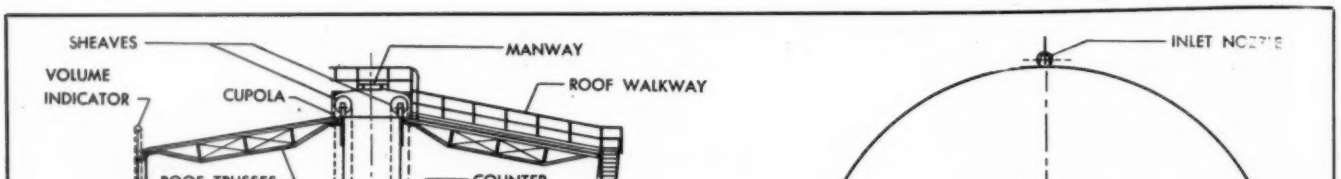


Fig. 1—Plan and elevation of gasholder as built at Lemont refinery of Globe Oil & Refining Co.

phragm of 14-gage steel plates and supporting trusses. When the gasholder is empty, the piston is at the top of the shell and rests against the roof structure, its trusses nesting within the roof trusses. As vapor enters through the vapor lines connected to the blending tanks, the slight unbalanced pressure pushes the piston downward until normal pressure is again obtained. As vapor returns to the blending tanks, due to contraction on cooling, or pumping products out, the piston rises. It is conical in cross section; thus, any condensate which may form collects in the pit of the cone and is automatically drained.

The balancing system, upon which the essential low pressure differential depends, consists of parts designed to resist wear and corrosion. Cables connecting the piston to the counterweight are of the so-called "Bethanized" type, in which the wires of each strand have been galvanized before the cable is formed. The cable sheaves have graphite-impregnated bronze bushings turning on stainless steel shafts, eliminating corrosion as well as lubrication, and providing the required low friction.

A 6-in., pressure-vacuum, liquid seal, vent valve is installed in the gasholder roof. This valve is designed to vent at ⅝ in. of water, pressure or vacuum, and it has the following venting capacities, based upon air:

Press. or Vac.	Flow (cfh)
0.625 in. H_2O	0
0.70 in. H_2O	10,000
0.85 in. H_2O	20,000
1.25 in. H_2O	30,000
2.00 in. H_2O	37,800

Condensate will form during abnormal temperature variations when the gasoline in the tanks is approximately at atmospheric temperature. In most cases, the condensate forming under such conditions will evaporate and be returned to the system as vapor. If the gasoline is above the ambient temperature, the entire vapor balancing system acts as a condenser, with liquid forming in the vapor lines and in the gasholder.

To take care of gasholder condensate, drains have been provided in the shell belt angle which catches the condensate formed on the upper shell surfaces; in the low point of the piston which catches the condensate formed on the underside of the roof and the piston surfaces; and in the bottom of the center column support. Any condensate which forms in the seal loop will drain onto the piston and be discharged through the piston drain when the piston reaches the full, or lower, position.

A. P. I. Construction

The six, 25,000-bbl., cone roof, blending tanks in the system at the Globe refinery are of standard API all-welded steel construction, 67 ft. diameter by 40 ft. high. Each tank is equipped with a 10-in. "Varec" vent valve and a 12-in. flame arrestor. The pipe fitting between the vent and flame arrestor has a 10-in. opening to which is connected the vapor feed line from the tank to the main vapor line. The vent valves are set to open at a pressure and a vacuum equivalent of 2-in. hydrostatic head.

The vapor piping consists of a 14-in. diameter main vapor line with a 10-in. feed line from the vapor space of each of the six tanks and with a 14-in. delivery line to the gasholder. A condensate sump is located at the low point in the vapor piping. Condensate collecting in this sump is pumped to the storage tanks.

Actual blending takes place in four of the six tanks, the other two being kept for standby needs. All tanks are equipped with "Lightnin' " side-entering agitators.

All blending equipment was completely replaced at Lemont when the gasholder was installed. Previous blending operations were handled in seven, cone roof tanks of smaller size —10,000 bbl. capacity. All these tanks were also equipped with vent valves in the roof. In two of them, blending was accomplished by circulation through a swing-line; in the others, side-entering agitators were used, as in the present arrangement.

Globe's Records

Globe's records of savings in gasoline losses, along with several methods of calculating monetary savings, are shown in Table 1. Loss figures were determined on the basis of complete records of tank gagings, transfers, and the like in the blending operations. Motion of the piston in the gasholders was not checked because Globe engineers felt that in-and-out pumping could be, and probably did, take place in one or more tanks many times simultaneously, with the result that the piston did not move perceptibly.

In general, the gasoline properties during the two periods were identical, the range of Reid vapor pressures being the same. During the 1948 period, Globe was making liquefied petroleum gases: during the 1947 period the C_3's and lighter were burned as fuel.

The figure of 11c/gal. for the gasoline was chosen arbitrarily so as to attempt a correlation with savings estimated on the same installation by General American Transportation Co.

engineers, who conducted a 24-hr./day, seven-day test in the spring of 1948.

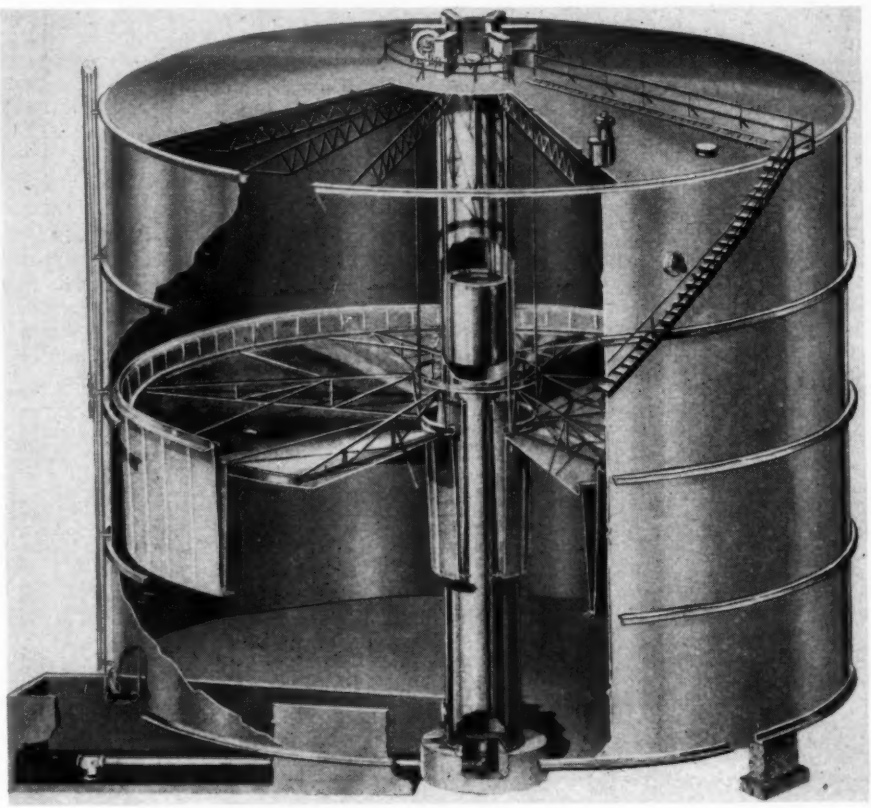
In general, the savings as calculated by General American are considerably lower than those from the Globe records. A preliminary report gives their estimate of annual savings as about $30,000. A complete final report revised this upward to about $52,000. General American's data is based on a mathematical calculation of the amount of gasoline that was retained in the system, and thus recovered, which would otherwise have been lost to the atmosphere. The Globe figure is an estimation of the gasoline saved in the year the vapor recovery system was in operation, as compared with their operations of the previous year. The theory and method of calculations employed by General American engineers are described below:

General American Tests

The test was run from 11:00 p.m., April 25, to 11:00 p.m., May 2, 1948. The operation of the system during the test was normal in all respects. The plant and the system were operating under load conditions considered normal for the time of the year the test was conducted.

Savings effected by the gasholder result from two sources: 1) the unbalanced vapor movements in the system, measured directly from the movements of the piston, and 2) the balanced vapor movements, measured by the changes in liquid level in the six tanks.

For example: when the gasholder piston moves downward and the volume of the gasholder is increased, the increase in volume represents the volume of air-gasoline vapor that would have been lost to the atmosphere. A decrease in volume indicated by the upward movement of the piston is a direct measure of the air-vapor mixture that has been returned to the storage tanks and saved. A record of piston movements would therefore enable a determination of the savings effected by the gasholder.



Cutaway drawing showing interior construction of gasholder

At the same time, savings also result from a balanced condition in the system where vapors transfer from one tank to another without changing the total volume of air-vapor mixture in the system; consequently having no effect on the piston position. This balanced condition can occur in several ways. It can be caused by simultaneously pumping into one tank and pumping out of another. It can also result from pumping into a tank and a thermal contraction throughout the system. Or, it can be the result of pumping out of a tank and a thermal expansion in the system.

During the General American test, piston movements were recorded. From these data the volume of gasoline vapor returned to storage tanks was calculated and the monetary value of the savings determined. For each piston position of the gasholder recorded, a volume was calculated. The readings of piston position were corrected for a zero calibration of the indicator. The volume for each reading was determined on the basis of the physical dimensions of the gasholder and corrected to a standard temperature of 60° F.

To make this temperature correction, it was assumed that the air-vapor mixture had the same temperature as the surrounding atmosphere. An example of the calculations follows:

Piston position reading (38 ft. 6 in.)—correction factor (0 ft. 8 in.) = corrected piston position (37.833 ft.)

Corrected piston position (37.833 ft.) × displacement of piston per ft. of movement (3,685) = displacement volume (139,415 cu. ft.)

Displacement volume (139,415) + dead volume (11,535) = total gasholder volume (150,950 cu. ft.)

Total gasholder volume (150,950) × (Abs. Std. Temp. °R/Abs. Atmos.

TABLE 1—Gasoline Recovery with and without Gasholder

(Derived from Globe Oil & Refining Co. Figures)

	Without Gasholder 11-14-46 to 11-14-47 bbls.	%	With Gasholder 11-14-47 to 11-14-48 bbls.	%
Gross gasoline produced	4,925,286	100	4,737,110	100
Treating loss(1)	34,983	0.71	23,774	0.50
Handling, transfer & evaporation loss	64,750	1.31	15,477	0.33
Ultimate gasoline produced	4,825,553	97.98	4,697,859	99.17

(1) Treating loss figures are shown only because they affect ultimate gasoline produced. Although a decrease is shown in this factor for the second over the first period, it is not caused by the Gasholder, which operates only on blending tanks.

Loss during blending without Gasholder ..... 1.31% of gross gasoline produced
Loss during blending with Gasholder ..... 0.33% of gross gasoline produced
Decreased loss, using Gasholder ..... 0.98% of gross gasoline produced

Calculated Savings, Method I

Gasoline produced during period with Gasholder = 4,737,110 bbls. gross
= 198,958,620 gals.
Gasoline saved during that period = 198,958,620 × 0.0098
= 1,949,798 gals.
Monetary value (at 11c/gal.) = $214,477.78

Calculated Savings, Method II

Loss without Gasholder = 64,750 bbls.
Loss with Gasholder = 15,477 bbls.
Gasoline saved = 49,273 bbls.
= 2,069,466 gals.
Monetary value (at 11c/gal.) = $227,641.26

TABLE 2—Vapor Balancing System Study—General American Transportation Co. Data

Date	Time Interval	Volume Saved	Aver. Atmos. Temp.	Average R.V.P.	% Vapor	Gasol. Vapor Volume	Gals. Gasol. Saved	Cumul. Savings
4-26	0600-0700	1,126	65	12.57	47.6	536	17.9	17.9
	0730-0900	964	67.7	12.57	49.7	479	15.9	33.8
	1030-1400	5,056	70.3	12.57	53.1	2,685	89.5	123.3
	1600-1630	232	72.5	12.57	55.1	128	4.3	127.6
	1930-2030	605	68.0	12.57	50.3	304	10.1	137.7
4-27	2100-0040	23,637	64.3	12.85	46.9	11,086	369.5	507.2
	0300-1000	34,374	59.9	12.85	43.5	14,953	498.4	1,005.6
	1230-1300	2,552	73.5	12.85	55.8	1,424	47.5	1,053.1
	1630-1700	9,591	65.5	12.85	48.3	4,632	154.4	1,207.5
	1830-2200	21,677	59.2	12.85	42.5	9,213	307.1	1,514.6
4-28	0030-0100	6,134	53.5	12.58	38.8	2,380	79.3	1,593.9
	0500-0530	161	52.8	12.58	37.8	61	2.0	1,595.9
	0700-0730	321	52.5	12.58	37.8	121	4.0	1,599.9
	0800-1230	2,572	56.2	12.58	40.8	1,050	35.0	1,634.9
	1300-1400	644	60.8	12.58	43.9	283	9.4	1,644.3
	1630-1700	464	57.0	12.58	41.5	193	6.4	1,650.7
4-29	1730-0030	17,071	49.3	12.58	35.2	6,009	200.3	1,851.0
	0230-0300	1,225	42.5	12.58	31.1	381	12.7	1,863.7
	0630-0730	1,760	47.0	12.58	33.3	586	19.5	1,883.2
	0830-0930	2,910	68.0	12.58	50.3	1,464	48.8	1,932.0
	1000-1100	983	68.0	12.58	50.3	494	16.5	1,948.5
	1130-1200	1,287	61.0	12.58	43.9	565	18.8	1,967.3
	1300-1330	1,608	57.5	12.58	41.5	667	22.2	1,989.5
	1430-1500	643	57.0	12.58	41.5	267	8.9	1,998.4
	1800-2000	14,455	49.0	12.58	35.2	5,088	169.6	2,168.0
4-30	2030-0030	35,215	42.3	12.58	31.1	10,952	365.1	2,533.1
	0230-0700	44,024	38.5	12.58	28.4	12,503	416.8	2,949.9
	1300-1330	319	73.5	12.58	55.8	178	5.9	2,955.8
	1500-2130	19,014	58.6	12.58	42.2	8,024	267.5	3,223.3
	2230-2330	986	47.0	12,58	33.8	333	11.1	3,234.4
5-1	0300-0330	3,456	48.0	12.58	34.2	1,182	39.4	3,273.8
	0400-0800	32,702	49.0	12.58	35.2	11,511	383.7	3,657.5
	0830-0930	3,124	54.7	12.58	39.5	1,234	41.1	3,698.6
	1300-1330	523	70.0	12.58	52.4	274	9.1	3,707.7
5-2	1500-1500	119,983	52.7	12.58	37.8	45,354	1,511.8	5,219.5
	1530-1630	46	48.7	12.58	34.9	16	.5	5,220.0

Total Volume Gasoline Vapor 156,610

Value of Savings = $574.20

Temp. °R) (520/509) = corrected gasholder volume (154,271 cu. ft.)

Corrected gasholder volume (154,271 — dead volume (11,535) = corrected displacement volume (142,736 cu. ft.)

The displacement of the piston for one foot of movement is equal to the area of the inside diameter of the gasholder shell minus the area of the outside diameter of the center cylindrical column. The dead volume is equal to the volume of the conical space under the roof, the center cylinder, and the conical frustrum formed by the piston.

Dead Volume Considered

The dead volume was taken into account in making the temperature correction because it affects the total gasholder capacity by its expansion and contraction with temperature changes. The calculated volumes were set down in chronological order so that all decreases in volume could be determined. These volume changes and the time intervals over which they occurred are shown in the calculated data sheet in Table 2. The saved volumes of gasoline vapor were then converted into gals. of gasoline and the summation of the individual savings is a saving effected for the test period.

Table 3 shows the saving of $574.20 for the week of the General American test and projects this for the year to show annual savings of $29,858.40 from the unbalanced vapor movement in the system. Also shown in the table is the net annual return for the system on the $38,333 capital investment in the Gasholder system. To have the complete picture of savings, however, it was also necessary to include the calculated savings for the system from the balanced condition, based on readings on each tank. How these latter savings were calculated is shown below:

Calculations

To determine the balanced vapor movements and resultant savings, the volume of the air-vapor mixture in each of the six tanks was calculated for each period of the day that readings were taken. The volume was calculated from the gage of the tank. These gages were made every half-hour for the entire seven days. The volume of the air-vapor mixture in each tank was determined as an outage volume, and the dead volume of the cone roof was added to it.

This volume was then corrected for atmospheric temperature, assuming that the air-vapor mixture in the tank was at atmospheric temperature. Then the change in volume between successive periods was determined as an increase or decrease in the volume of air-vapor mixture in the tank. This was done for each of the six tanks. The final result was a tabulation by half-hour intervals of the change in vapor volume, tank by tank. The algebraic summation of these volume changes is equivalent to volume changes in the gasholder, i. e., it is the *unbalanced* vapor movement. The lesser sum of the increase or decrease would then be the *balanced* vapor movements.

Stated mathematically, the balanced vapor movements is equal to the arithmetic sum less the algebraic sum divided by two. The calculation is illustrated in the example in Table 4 which gives the corrected volume and change in volume in cu. ft. over a half-hour period for all tanks in the system:

The algebraic sum, which is the unbalanced pumping for the particular half-hour period chosen, is equal to 3229 cu. ft. Investigation of table 4 shows that there are increases in volume for tanks 80 and 85 and a decrease in tank 84. The decrease in volume in tank 84 being less than the sum of the increases in tanks 80 and 85 represents the balanced pumping.

Repeated every Half-hour

This procedure was repeated for every half-hour period of the study; thus the total balanced vapor volume changes was determined and showed a balanced vapor movement of 262,504 cu. ft. This was vapor that would have been lost to the atmosphere had it not been for the vapor balancing system, thus it was a saving.

Based on the average Reid vapor pressure of the gasoline stored during the test period, this volume of vapor is equivalent to 3869 gals., which at 11c/gal. represents a monetary savings for the week of $425.60. Projected over 52 weeks, the annual savings becomes $22,131.20. If this in

turn is added to the savings of $29,858.40 found made by the gasholder as unbalanced vapor movements, the gross saving for the installation would be $51,989.60 per year.

Still another study of the Lemont installation and the Globe figures was made by John Wiggins, and showed a close correlation to the estimated savings by Globe engineers. Mr. Wiggins found the savings to to about $212,520, again based arbitrarily upon 11c/gal. gasoline. His analysis follows:

"The record at Lemont shows the following facts,

"1. 4,900,000 bbls. of gasoline handled in 1947.

"2. 4,700,000 bbls. of gasoline handled in 1948.

"3. The average Reid vapor pressure was 10.5 psi.

"4. The accounting report shows 1.31% loss of throughput in 1947.

"5. The accounting report shows 0.33% loss of throughput in 1948.

"In addition to these facts, the other known conditions of gasoline storage and handling must be considered. We know that the gasoline pumped into blending tanks and thence into storage was hot in 1947. As late as November, 1947, a temperature check on a nearly full tank showed gasoline at the bottom to be at 70° F., while atmospheric temperature was 35 to 40° F.

Temperature Averages

"Therefore, we can assume the average temperature of the gasoline pumped during the six cold months of the year as 75° F., and during the six hot months as 85° F. Since the average RVP is 10.5 psi., then we calculate the partial pressure of the gasoline vapor at 75° F. to be 7.2 psi., and at 85° F. to be 8.6 psi. Percentage-wise, this is 48 and 58.5% respectively, or an average for the year of 53.2% of the air-vapor mixture is gasoline.

"The record shows that 4,900,000 bbls. of gasoline were handled through these tanks. It was pumped several times. For purposes of analysis, we made the reasonable assumption that it was pumped 2½ times. That much gasoline pumped 2½ times would displace 70,200,000 cu. ft. of air-vapor mixture which which would be lost to the atmosphere with no vapor saving device. As shown above, 53.3% of this is pure gasoline vapor, or 37,400,000 cu. ft.

"Based on the figure of 28 cu. ft. of vapor to the gallon of gasoline, we find the loss to be 1,335,000 gals, or 31,800 bbls. This happened during the 12-month period, November 14, 1946 to November 14, 1947. It is the so-called 'pumping loss.'

"Loss af gasoline due to standing in storage has been safely estimated at 3% of the volume of tankage involved. Tankage in this case is about 500,000 bbls. Standing loss then is 15,000 bbls. The combined standing and pumping loss totals 46,800 bbls., which is 0.955% of the throughput of 4,900,000 bbls.

"The record tells us that 1.31% of the 4,900,000-bbl. throughput was actually lost, or 64,100 bbls. The difference between the loss figured theoretically and the actual loss is then 17,300 bbls., or 0.355% of the throughput. This difference between theoretical and actual loss may be accounted for in several ways:

"1. During blending (We have no way of determining theoretically the amount of evaporation caused by mixing and blending)

"2. Human error in handling gas tight tanks, such as leaving gage hatches open, etc.

"3. Leakage—from tank bottoms, valves, gaskets, other mechanical equipment.

"For the second one-year period, several changes were made. Mixing and blending tanks were connected to the 150,000 cu. ft. Gasholder. These were new tanks, equipped with gas tight, ground level, reading gages, and sample draw-off cocks in the tank shell. Such equipment reduces the possibility of human error. In addition, two 80,000 bbl. tanks equipped with "Wiggins Hi-Dek" floating roofs were put in service. These tanks handled the active pumping operations. The remaining 200,000 bbls. of tankage was not changed. It remained the same as the total tankage for the preceding year, when all tanks were simply gas tight with vent valves and no other evaporation protection.

"By the record, the second one-year period showed an unaccountable loss of 0.33%, which based on the throughput of 4,700,000 bbls. was equal to 15,500 bbls.

"The savings effected by both the gasholder and the floating roof tanks are the difference between the percentage of unaccountable loss for the two years. This is 1.31% minus 0.33% or 0.98%. Applied to the 1948 throughput, this is equal to a saving of 46,000 bbls. We can now make a comparison of this figure with the theoretical savings in standing and pumping loss.

"Taking 0.955% of 4,700,000 we obtain 44,800 bbls. The difference then between theoretical and actual savings is 46,000 minus 44,800, or 1200 bbls. This close correlation is within the limitations of the data and the method of calculations, and can be considered in good agreement. It might, however, be considered an indication of blending loss, depending on the accuracy of our assumptions and the data used.

Annual Savings

"The annual saving of 46,000 bbls, based on our arbitrary cost for the gasoline of 11c/gal., then is $212,520."

The relatively wide variations in savings calculated by Globe and Mr. Wiggins as compared to those determined by General American engineers is not fundamentally important. The installation has been definitely demonstrated to have reduced valuable evaporation losses at an economic return on the cost of the equipment used.

Globe is well satisfied with the system and is contemplating the installation of a similar arrangement on their rundown tanks, according to G. G. Woodruff, secretary and treasurer of the Globe Oil & Refining Co.

TABLE 3—Net Savings from Unbalanced Vapor Movement—General American Transportation Co. Data

Capital Investment:	
Foundations	$ 3,428.00
Gasholder in place and painted	29,805.00
Vapor piping in place and painted	5,100.00
Total Capital Investment	$38,333.00
Gross Annual Costs:	
Interest @ 5% on capital investment	$ 1,916.65
Depreciation on 15-year basis	2,555.55
Taxes and insurances	1,320.00
Maintenance	200.00
Operating	520.00
Gross Annual Cost	$ 6,512.20
Gross annual returns 52 weeks @ $574.20	$29,858.40
Gross annual cost	6,512.20
Net Annual Returns	$23,346.20
Percent net annual returns on the capital investment	$\frac{\$23,346.20 \times 100}{\$38,333.00} = 60.9\%$

TABLE 4—Calculation of Balanced Vapor Movements

Time	Tank 80	Tank 81	Tank 82	Tank 83	Tank 84	Tank 85
2200.....	111,665	22,159	14,270	101,340	63,975	25,870
2230.....	111,811	22,159	14,270	101,340	62,121	30,807
Change	146	0	0	0	—1,854	4,937

MODERN SOLVENT REFINING OF LUBRICATING OILS

Article 4—Solvent Characteristics; Estimating Yields and Qualities of Solvent Refined Products

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Accurate evaluation of the selectivity and solvent power of solvents under consideration is essential to successful commercial operation. For example; solvent power increases while selectivity usually declines with a rise in extraction temperature. The method of extraction—direction of flow and continuous or stage operation—is also an important factor. However, thorough mixing does not appear as essential as once believed.

Advantages of the continuous tower method of extraction are presented; the complexity of variables, however, adds to the difficulties of reproducibility to laboratory standards. Logarithmic charts are shown to be useful in the estimation of yields and qualities. Several examples are given of the calculations employed with such charts.

MANY solvents are known that can be used for extracting petroleum oils. When these solvents are added to the oil, they are at first completely dissolved in it but, with the increased volume of solvent the homogeneous solution splits into two phases: solution of solvent in oil, which is the raffinate phase, and solution of oil in solvent, which is the extract phase. Further increase in the quantity of solvent results in the gradual disappearance of the raffinate phase until all of the oil is dissolved by the solvent.

When the temperature is raised the same phenomena is observed with the exception that the solubility of solvent in oil and oil in solvent is greater. For this reason the region within which the two separate phases exist is reduced. At still higher temperatures these mutual solubilities may be so great that solvent and oil become miscible in all proportions and the solvent loses entirely its preferential solubility characteristics. The complete miscibility temperature varies both with the nature of the solvent and the nature of the oil.

As was mentioned, petroleum is a mixture of a very large number of chemical compounds. Their solubility characteristics vary in the same imperceptibly small increments as do their physical and chemical properties. Those of the compounds which are most soluble in the solvent are the first to appear in the extract phase. It happens that these same compounds impart undesirable characteristics to the finished oil as reflected in their wide variations in viscosity with temperature, i.e., low viscosity index, high carbon residue and general instability. As a result of solvent extraction, properties of the oil left in the raffinate phase are improved.

The best solvent is the one which is capable of creating maximum differences in properties between the extract and raffinate phases for the minimum loss of oil to the extract. This statement, however, requires clarification which shows how difficult it is to generalize on this apparently simple subject.

Solvents vary widely in their solubility characteristics. Some may have a high solvent power and poor selectivity, i.e., they may dissolve large volumes of oil but fail to create appreciable differences in properties between the extract and raffinate. Others may have the opposite characteristics, i.e., low solvent power and high selectivity, while the rest may appear in any other imaginable classification. It may be mentioned that, notwithstanding some indications to the contrary, all selective solvents may be considered alike in their preferential solubility characteristics towards the low viscosity index and high carbon residue constituents, which simplifies theoretical analysis of their behavior.

Solubility of oil in solvent increases with a decrease in the boiling point of the oil fraction and the increase in the low viscosity index constituents which this fraction contains. Coastal oils are for this reason more soluble than oils of Mid-Continent and, particularly, Pennsylvania types, while distillate fractions are more soluble than the residua. Subject to some physical limitations, such as melting or boiling points, any solvent may be used for extracting all types of oils provided temperature and quantity of solvent are properly adjusted. However, the amount of solvent may become prohibitive commercially, while the temperature required might be so low that the oil becomes viscous and difficult to handle or to mix with the solvent, particularly if the wax is precipitated. All these considerations are taken into account when choosing the solvent to be used.

A detailed study of solubility characteristics of solvents shows that their solvent power increases with the rise in extraction temperature while their selectivity usually declines slowly until the temperature is reached close to miscibility when the loss in selectivity is rather abrupt. As a result, oil losses always increase with the increase in extraction temperature but properties of the raffinate may first improve and then deteriorate as the temperature is raised.

One other very important factor must be taken into account in evaluating selectivity and solvent power of solvents, namely, the method of extraction. Solvents are contacted countercurrently with the oil, which may be done by repeated mixing and

settling operations or by using towers. The fresh solvent is brought in contact with the raffinate layer leaving the system, while the oil charge is first extracted with the solvent which is ready to be discarded. As the solvent gradually works through the system it becomes more and more saturated with the low viscosity index constituents and because of its limited solvent power is forced to release the high viscosity index constituents which it dissolved when it first entered the system. The number of extraction stages or the height of extraction tower, assuming no changes in the design of equipment, determine the sharpness of separation between the low and high viscosity index constituents.

The discussion also shows that deficiency in the selectivity of the solvent can be made up by an increase in the number of extraction stages. Solvents of equal solvent power but different selectivities may yield the same quality raffinate provided the number of extraction stages is correspondingly greater for the low selectivity solvent. This is quite important because by applying such corrections differences in selectivity characteristics of various solvents may be equalized.

Thorough Mixing Not Needed

The thorough mixing of the solvent with the oil does not appear as important as it is sometimes believed to be. A reasonable degree of agitation is necessary to establish equilibrium but no advantage is gained by carrying it to extremes. If this is done the settling time might be extended to a point where the capacity of the extraction system is seriously affected. The optimum degree of agitation will vary with the type of equipment on hand and the characteristics of the oil and solvent. Because of the many variables involved, no one method is known that can be used with any degree of certainty for each individual case. However, the general tendency is to provide too much rather than too little agitation.

Continuous countercurrent extractions involving mixing and settling stages provide an absolute standard for comparing the performance of various equipment. Results thus obtained are always reproducible, if a reasonable degree of caution is exercised in mixing and settling the solvent and oil layers. However, the same degree of absolute reproducibility cannot be secured in operation of extraction towers where the number of variables is multiplied and some of them are beyond the operator's control.

In a continuous tower the oil is usually introduced at a point close to the tower's bottom while the solvent is fed from the top. The raffinate and the extract layers are removed from the top and bottom respectively. The upper portion of the tower has the raffinate layer as the continuous phase with the solvent passing through it in the form of droplets or narrow streams. The lower portion of the tower has the solvent layer as the continuous phase with oil droplets rising to the top. A dividing line between the two continuous oil and solvent phases exists in every tower.

Even Distribution

The oil and solvent, during their respective upward and downward flow, pass through the so-called "mixing" and "settling" sections in order to distribute as evenly as possible throughout the whole cross-section of the tower and provide means for breaking up the larger streams and avoid channeling. The mixing sections may be specially designed plates or may be packed with Raschig rings and similar materials. The settling sections are free of any such restrictions. In packed towers the settling sections are sometimes omitted.

The above description shows the complexity of the variables involved in tower operation. The size of droplets or streams into which the oil and solvent phases are broken depends not only on the mechanical factors, which are very important, but also on the viscosities and relative specific gravities of the two layers, i.e., nature of the oil and the solvent, operating temperature and the rate of feed. These two variables are to a considerable extent interdependent. Therefore, the optimum feed rates vary from one charge stock to another and with treating conditions. For this reason it is hardly possible to assign a "stage equivalent" to towers except qualitatively and subject to considerable fluctuation. The writer had an occasion to listen to an argument that for a certain operation a "two-stage" system showed "better extraction efficiency" than a "three-stage" system. The argument was settled when it was found that the two-stage system was a batch system while the three-stage system was a tower, the efficiency of which was established by using "standard" liquids and treating conditions having no relation to the "actual" liquids and conditions of tower operation.

Separation Improves

With the increased number of contact stages in batch systems or with the increased height of the tower, the separation between the desirable and undesirable constituents improves in sharpness. As was mentioned, a less selective solvent can thus be made equal to a more selective solvent in practical performance. Design of commercial equipment used with individual solvents normally employs a safety factor to minimize the effect of relatively minor fluctuations in feed rates, nature of charge stock and changes in treating conditions, although in some instances the observed differences between plant and laboratory performances may be appreciable. For the same reason it is always desirable to compare plant results by employing an absolute laboratory standard, i.e., countercurrent batch extractions, and not experimental towers because of the uncertainty involved in interpreting the results thus obtained. Laboratory towers are of value only in developing improved commercial design for such equipment but not for studying its performance after a commercial plant is in operation.

From the practical point of view the use of solvent extraction towers in large scale operations is well justified because of their simplicity of construction and ease of operation. Therefore, the above discussion should not be construed as a criticism of their wide application by the industry, but only as a caution in interpreting the results of plant performances in the terms of laboratory data.

Estimation of Yields and Qualities

Estimation of yield and quality of products obtained in solvent refining of lubricating oils on the basis of fundamental laws of chemistry and physics is hardly possible because of the indefinite composition of petroleum oils and the variable nature of raffinate and extract phases. Theoretical equations involve conceptions of the existence of two immiscible phases and a well defined impurity which distributes itself between these phases without affecting the preferential solubilities of the solvents by the increase in impurity concentration.

In solvent extractions no line can be drawn between the low and high viscosity index constituents or between impurity and the refined oil which in this case becomes a second solvent. Although a way might be found to express changes in the distribution coefficient as functions of the quantities and nature of the low viscosity index constituents removed, it seems doubtful that the resulting equations would be sufficiently simple to justify their use for the solution of practical problems.

Inspection of available data on solvent extraction of lubricating oils shows that the plot of oil fraction dissolved by the solvent against the quantity of solvent used, both expressed on volumetric basis, is closely approximated by a straight line on a logarithmic paper, provided the extraction temperature and the method

of applying the solvent remain unaltered.[20] This straight line relationship holds for solvent ranges well within those used in commercial practice and in most instances might be carried to very considerable extremes.[21]

The above method of estimating the quantities of oil dissolved by the solvent applies not only to selective solvents but also to deasphalting and dewaxing solvents. However, with the deasphalting and dewaxing solvents the refined product is in the extract or solvent layer while with the selective solvents it appears as the raffinate.

Example 1: A petroleum distillate was extracted with one and eight volumes of liquid sulfur dioxide at a constant temperature and using the identical method of applying solvent to the oil. The quantities of oil dissolved by the solvent were 9.5 and 25.5% by volume on the oil charged to the unit. Estimate the percentage of oil dissolved by the solvent when two and four volumes of solvent are employed.

The problem is solved graphically by plotting on a logarithmic paper percentages of oil dissolved by the corresponding quantities of solvent and drawing a straight line through the two points. From this line the quantities of oil dissolved by two and four volumes of solvent are estimated at 13.2 and 18.4% vol. respectively. This compares with 13.2% and 18.3% vol. found by experiments.

The algebraic solution is equally simple:

$$\log 0.095 = a \log 1 + b$$
$$\log 0.255 = a \log 8 + b$$

The general equation is, therefore:

$$\log L = 0.475 \log S - 1.022$$

where L is percentage of oil dissolved by the solvent and S is the volume of solvent used. By substituting in the general equation the values of two and four for the quantities of solvent the same results are obtained as those secured by the graphical method.

A change in extraction temperature has a considerable effect on the position of the line on the logarithmic paper. If temperature is the only variable and the volume of solvent and other conditions of extraction remain unaffected, semilogarithmic paper is employed for estimating the fraction of oil dissolved by the solvent. The natural scale is used for plotting temperatures in °F. and the logarithmic scale for plotting the oil fractions.

Example 2: Petrolatum wax extracted with three volumes of a dewaxing solvent at 0° F. and 80° F. The quantities of material dissolved by the solvent were 19 and 62% vol. respectively. Estimate quantities of material dissolved at 30° F. and 60° F.

By plotting percentages of materials dissolved by the solvent on the logarithmic scale and temperatures on the natural scale and drawing a straight line through the two points, percentages of materials dissolved by the solvent at 30° F. and 60° F. are estimated at 30 and 46% vol. These calculated results coincided with the experimental data.

The algebraic equation covering these extractions is:

$$\log L = 0.00641\ T - 0.721$$

The equation involving both quantities of solvent (S) and temperature (°F) contains four constants (a, b, c, d,) requiring four experimental points for estimating fractions of oil dissolved by the solvent (L) under any conditions of extraction provided the method of applying the solvent is the same.

$$\log L = (a + b°\text{F})\ \log S + c + d°\text{F}.$$

Example 3: The following results were obtained in extracting a deasphalted and dewaxed residual oil with chlorex:

Temp. ° F	Chlorex vol./vol. oil	Fraction of oil Dissolved By Chlorex
50	12	0.355
60	6	0.305
80	6	0.405
90	6	0.465

Estimate fractions of oil dissolved by nine volumes of chlorex at 110° F. and by twelve volumes at 70° F.

The equation developed from the available data appears as follows:

$$\log L = (0.426 - 0.00014 \times °\text{F})\ \log S - (1.212 - 0.0062 \times °\text{F})$$

From this equation it may be calculated that the fraction of oil dissolved by nine volumes of chlorex at 110° F. is 0.728 and by twelve volumes at 70° F. is 0.469. The experimental data were 0.725 and 0.475 respectively.

In using the experimental data and in estimating the product yields a certain degree of caution is required because reproducibility of the results in the laboratory is seldom better than ±1% while variation in the observed plant yields are even greater. For this reason reporting to fractions of a percent is justified only in exceptional cases when the work is done by skillful personnel and the results are carefully scrutinized.

Two methods of estimating yields of solvent refined products can be used. One method is the usual one of measuring actual volumes of charge stocks and products. When chemical changes are taking place this is the only way which can be used although it is subject to many uncertainties, particularly on a plant scale where considerable difficulties are encountered such as in estimating volumes and in making suitable corrections for slop materials. The conditions are aggravated whenever running gages are employed. The second method involves calculating yields from specific gravities. This method gives considerably more accurate results than the first method but is applicable only to those processes where separation of the undesirable constituents is based on physical principles, i.e., when properties of the original charge are the same as those of the materials into which the charge is separated and no changes in volume occur on blending.

Gravity yields can be used very conveniently in estimating results of deasphalting and solvent refining operations. However, they are not always reliable for dewaxing processes because of relatively small gravity differentials between the wax and the dewaxed oil. If the method is used for the latter purpose exceptional care must be exercised in taking gravities as otherwise the results might be erratic. Gravity yields are calculated from the formula:

$$\text{Yield (\% vol)} = \frac{\text{Sp. Gr. of Charge} - \text{Sp. Gr. of Extract}}{\text{Sp. Gr. of extract} - \text{Sp. Gr. of Raffinate}} \times 100$$

Quality of refined oils may be estimated by employing relationships similar to those for calculating yields.[22]

However, difficulty is encountered in the use of conventional units for designating oil quality which are quite arbitrary and usually not additive. Notwithstanding these limitations very satisfactory results are obtained provided the data are interpolated within reasonable limits. The only difference in plotting or calculating the results is that the difference in properties, such as viscosity indexes or viscosities, between the raffinate phase and the charge is used instead of yields.

Example 4: The following results were obtained in extracting a deasphalted and dewaxed residual oil of 65 viscosity index (V.I.) with phenol.

Temp. °F	Phenol vol./vol. oil	Vis. Index of Raffinate
110	3	89.8
120	1	84.7
140	2	90.2
150	1	87.3

Estimate viscosity indexes of raffinates obtained by extracting the oil with three volumes of phenol at 160° F. and two volumes at 130° F. The equation developed from the above data assumes the form:

$$\log(\text{V.I.} - 65) = (0.302 - 0.00049 \times °\text{F})\ \log S + (1.079 + 0.0018 \times °\text{F}.)$$

From this equation it may be calculated that viscosity index of the fraction obtained by extracting the oil with three volumes of phenol at

160° F. is 94.8 and that obtained with two volumes of phenol at 130° F. is 89.3. The experimental results were 94.6 and 89.3, respectively.

Raffinate and Extract

Composition of raffinate and extract phases can be calculated by employing similar procedures.(23) In these computations the oil is considered as the solvent and the solvent as the solute which permits the use of the straight-line logarithmic relationship between the fraction of total solvent employed and the oil to solvent ratio, while in the previously described computations involving product yields, the fraction of total oil present was plotted against the solvent to oil ratio. Calculation of actual percentages of solvent and oil is thus reduced to a simple arithmetical calculation.

Comparison of Solvents

As has been mentioned, solvents differ from each other in their selectivity and solvent power. However, no quantitative expressions for estimating these properties were presented.

Selectivity (M) can be defined as the difference in properties between the raffinate and oil charge caused by the removal of a portion of the oil by the solvent. This function can be shown to be the same as the difference in properties between the oil charge and extract divided by the undissolved fraction of the oil.

$$M = \frac{P_o - P}{L} = \frac{P' - P_o}{1 - L}$$

where P_o, P and P' are additive properties of oil charge, raffinate and extract, respectively, L is the fraction of oil dissolved by the solvent and $1 - L$ is the undissolved oil fraction. This function plotted against the volume of solvent used is represented by a straight line on the logarithmic paper. (24)

Solvent power (N) may be defined as the fraction of oil dissolved by the solvent (L) divided by the volume of solvent employed (S), or

$$N = \frac{L}{S}$$

Solvent power plotted against the volume of solvent used is also represented by a straight line on the logarithmic paper.

The product of selectivity and solvent power may be considered as the refining power (R) of the solvent.

$$R = \frac{P_o - P}{S}$$

The plot of refining power against the volume of solvent used is again represented by a straight line on logarithmic paper.

High selectivity shows that few extraction stages are necessary to obtain a sharp separation between the desirable and undesirable oil fractions. High solvent power indicates that a small volume of solvent may be used to obtain the separation assuming that the number of extraction stages is adjusted to erase possible differences in the selectivity of solvents. High refining power indicates that a small volume of solvent is sufficient to insure a big improvement in the properties of the raffinate provided the number of extraction stages is sufficient to insure a sharp separation between the two phases.

All these three functions change with temperature. The straight lines referring to the individual temperatures usually show the tendency to converge to a common point. The position of this point varies with the extraction method, type of solvent and nature of the oil used. Disregarding physical limitations of oils and solvents such as melting or boiling points, these plots indicate that the number of extraction stages and the extraction temperature may be adjusted to secure the same results with any one of the selective solvents.

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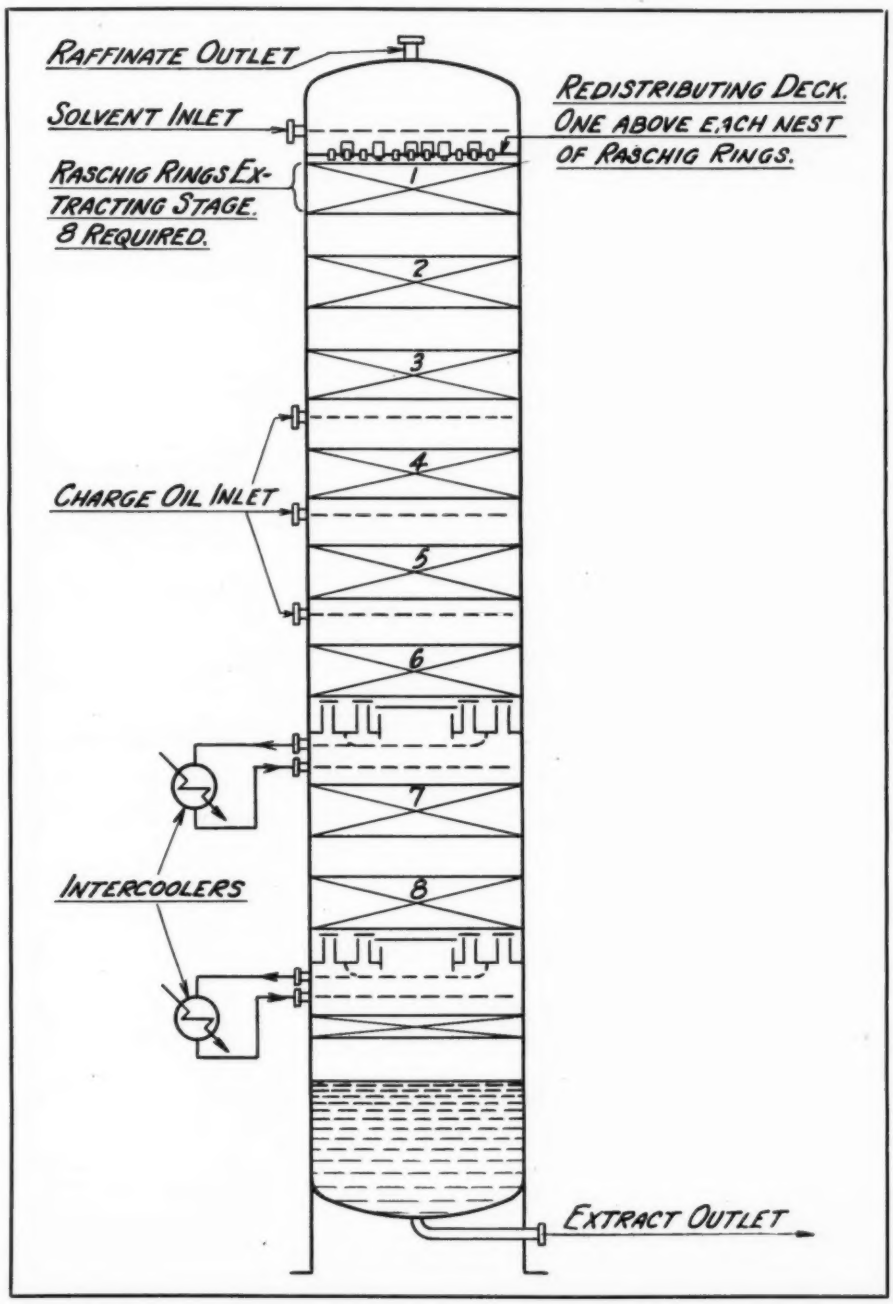

Simplified sketch of a current type extraction tower used in furfural solvent refining plants (Drawing courtesy The Lummus Co.)

Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

By ALAN S. GLENDENING and CHARLES F. SANDERSON
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Article 3

IN the preceding articles of this series we have studied the rich oil de-ethanizer, a unit which makes possible the efficient recovery of propane previously extracted in the main absorber. The question now arises as to how the main absorber's extraction characteristics may be improved.

Any one of three alternatives, or a combination thereof, will do this: (a) Increase oil circulation; (b) Increase the absorber operating pressure; (c) Refrigerate the absorber.

When designing new plants, two general situations determine operating pressure:

(a) Residue gas is to be delivered to a pipeline. In this case the main absorber operates at a pressure just above the residue gas delivery pressure. (b) Residue gas is to be injected into a field. In this case the main absorber will probably operate at a pressure much lower than either the field or injection pressure.

Under either of these circumstances the operating pressure is fixed by considerations which do not affect the advisability of absorber refrigeration. Consequently, the cost of absorber refrigeration need only be weighed against savings in oil circulation equipment and recompression horsepower. Such considerations indicate that at present refrigeration is rarely justified in new plants. (It should be noted that the development of more efficient and/or inexpensive compressors may invalidate this generalization.)

With regard to improving propane extraction in an existing plant, the situation is quite different. Large increases in oil circulation or operating pressure necessitate radical changes in the existing plant facilities and, as a consequence, refrigeration is frequently the best solution.

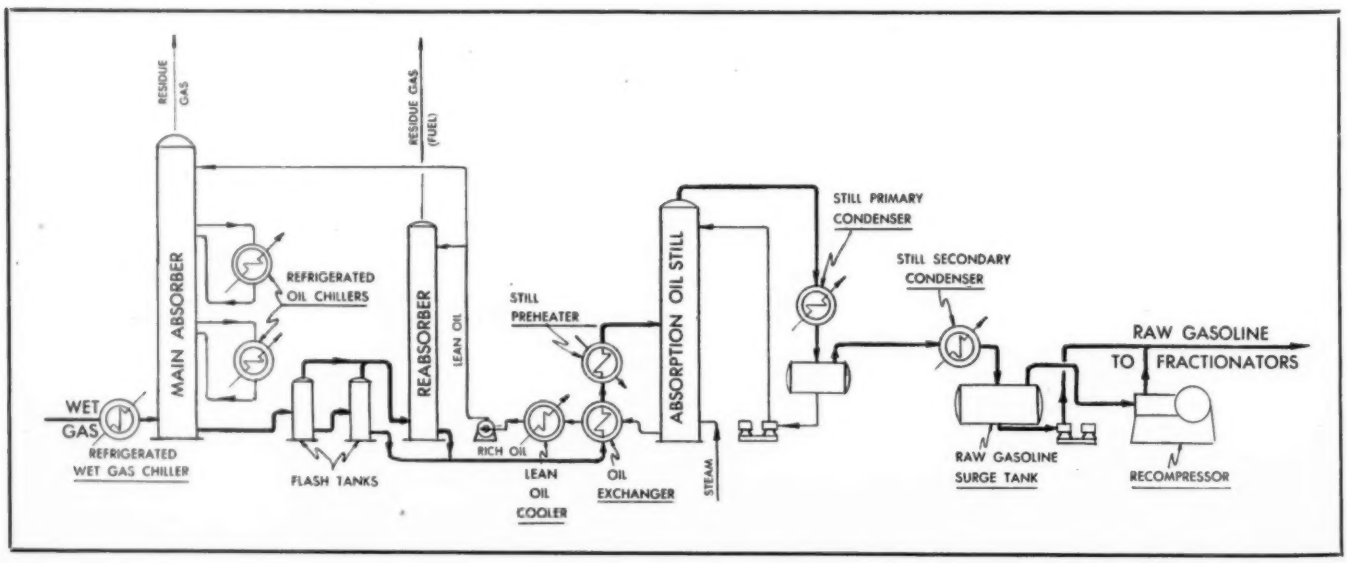
The adaptation of a plant to refrigeration is usually accomplished with few changes in the existing facilities and a relatively short plant shutdown. Except for adapting the absorber, the entire absorption and distillation areas will probably remain intact. Additional still condensers and product coolers may be required, but may be installed in parallel with existing equipment. Larger fractionating towers also may be required. If the plant is the type in which the only product separation is performed in a stabilizer (gasoline and LPG production only), a fractionating de-ethanizer (or rich oil de-ethanizer) and a depropanizer must be added for the production of propane. In such a case the stabilizer will usually remain as a debutanizer. Figs. 9 and 10 show the absorption, distillation, and fractionating areas of the revised plant.

Frequently it will be found that no additional boiler capacity will be required since the bulk of the boiler load is consumed in absorption oil distillation; the latter is only moderately affected by the increased raw gasoline content of the rich oil. However, cooling tower capacity will almost certainly have to be expanded to allow for the large duties of compressor jacket water coolers and oil coolers and of the refrigerant condensers.

Before proceeding to a detailed examination of problems concerning the absorber and the refrigeration system, some discussion is in order with regard to the de-ethanizer.

Regardless of how many flash and reabsorption stages may be installed in the conventional process, a substantial amount of methane and ethane must inevitably carry through to the fractionators and contaminate production. The requirements for propane of commercial grade list 95% purity with a maximum vapor pressure of 225 psig at 105°, requirements which cannot be met where

Fig. 9—Absorption and distillation systems with refrigerated absorber



the propane contains more than a trace of methane and more than 2 or 3% of ethane. In the fractionating system shown in Fig. 10, a fractionating de-ethanizer has been included to obviate this difficulty. From the raw gasoline, this unit removes overhead all the methane and all but the small amount of ethane consistent with the production of propane of commercial purity. This de-ethanized gasoline is then processed in a depropanizer for the production of propane and in a debutanizer for the production of butane and natural gasoline.

The de-ethanizer usually consists of a 24 to 30-tray tower operating at about 450 to 500 psig, with reflux that is colder than is usual to natural gasoline plant fractionating towers—within 5 to 10° of the cooling medium's inlet temperature. Unlike most fractionators whose operating pressures are limited because of reboiler steam or condenser water temperatures, de-ethanizer operating pressure is limited to the critical pressure of the bottoms. In fact, operation must be held well below this pressure or reboiler vapors will be produced in unmanageably large quantities.

Quite a bit of de-ethanizer trouble has been encountered, particularly in earlier installations, these troubles usually arising from two sources: (a) Incorrect tower sizing; and (b) Incorrect systems of tower controls.

Incorrect tower sizing may occur because of the habit of obtaining tower diameters as a function of vapor loading while paying insufficient attention to the problem of liquid loading. Sizing towers on a vapor basis is satisfactory in the design of stabilizers, depropanizers, and debutanizers with the tray spacings and reflux ratios usually employed. With the de-ethanizer, however, the liquid to vapor ratio below the feed is frequently so high as to make liquid loading control the choice of tower diameter. One way of making an equitable use of tower volume without resorting to a bottle-shaped tower is to use greater tray spacing below the feed than above—20 or 22 in. below and 18 in. above, for example. Partially vaporizing the feed in a preheater also helps in this respect. Tower diameter as a function of liquid loading has been admirably treated in recent literature[1].

The most satisfactory way of controlling a de-ethanizer (Fig. 11) consists in applying constant heat input at the base by means of a steam flow controller and returning all the reflux that can be condensed. Thus, if too much ethane should appear in the propane product, stepping up the steam input will automatically increase reflux and provide a closer cut. At all times, there will be accomplished maximum propane retention consistent with reflux condenser

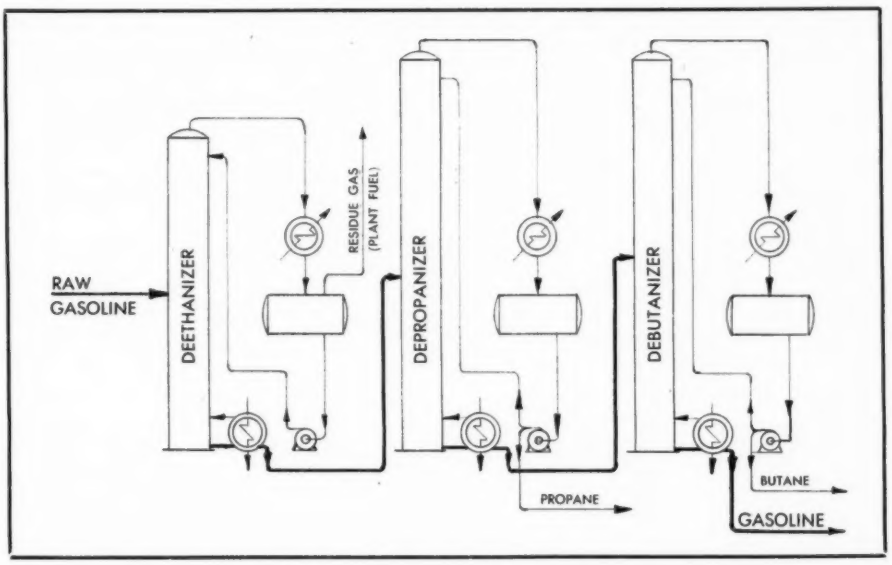


Fig. 10—Fractionation system using a fractionating deethanizer

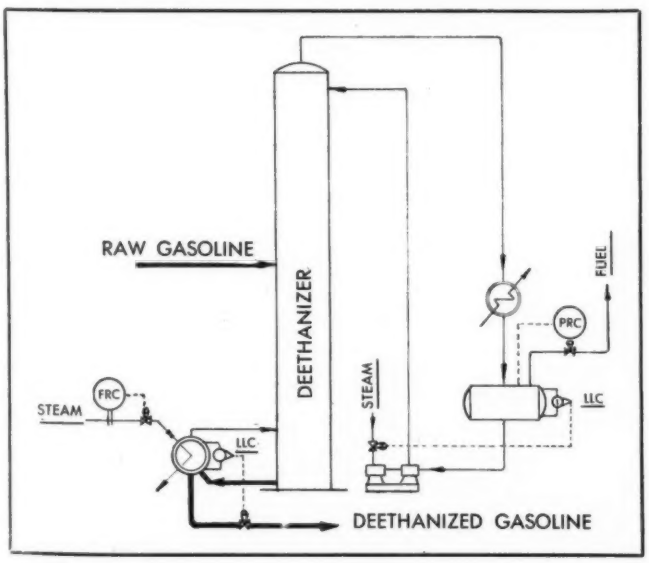


Fig. 11—Above: Fractionating deethanizer controls. FRC—flow recorder controller. PRC—pressure recorder controller. LLC—liquid level controller

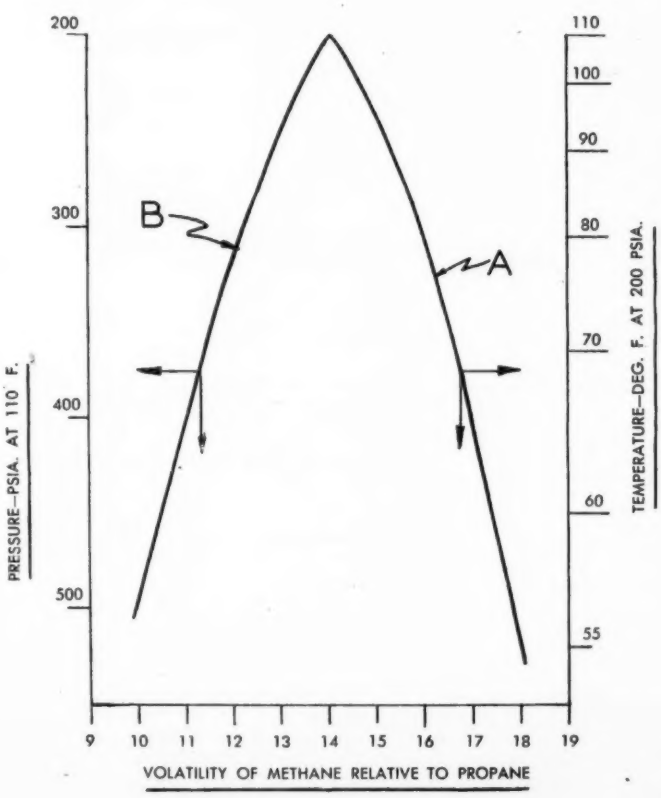


Fig. 112—Right: Effect of temperature and pressure on relative volatility

conditions. Note that with this arrangement there is never any fear of running out of reflux, providing the tower is large enough and has proper internal design.

Some de-ethanizers have been installed with control systems similar to those used on stabilizers: temperature control at the reboiler and flow control of the reflux. This arrangement is satisfactory for the production of a constant vapor pressure bottom product as in a stabilizer, but in a de-ethanizer such a system tends to limit the propane in the bottoms to some constant proportion while not taking advantage of the additional propane recovery possible due to variations in cooling water temperature (if water is used) and raw gasoline composition.

Refrigeration vs. Absorption

In revamping an existing plant the question arises as to whether or not it would be preferable to apply compression horsepower directly to the incoming wet gas and process this gas at a higher pressure rather than use refrigeration. Only one factor can work in favor of the higher pressure operation: a market for high pressure residue gas. If such a market is not available, a number of considerations make higher pressure operation undesirable.

(a) Heavy equipment. A new high pressure absorber would be required —also auxiliary high pressure vessels (scrubbers, etc.) and piping. The old absorber and auxiliaries in an existing plant would have no use in the new arrangement.

(b) Retrograde effect. A hydrocarbon mixture which may be condensed by applying pressure will commence to re-evaporate at a much higher pressure, this being known as the retrograde effect. This effect may be studied in terms of K values by noting that the K's of the various hydrocarbons first decrease with increasing pressure, then reach a turning point and begin to increase. The effect is especially marked for the heavier components; octane, for instance, undergoes its turning point at about 300 psig and thereafter the K of octane increases rapidly with increasing pressure.

The retrograde effect affects oil absorption in two general ways. First, heavy components such as are contained in absorption oil become volatile at high pressures, and consequently a severe loss of absorption oil into the residue gas may result. Second, at very high pressures key components such as propane and butanes begin to increase in volatility and resist absorption. The point at which increased pressure necessitates *increased* oil circulation is somewhere between 1000 and 1500 psig for most cases.

(c) Poor separation. The relative volatilities (ratio of K's) of methane and ethane with respect to propane decrease with increasing pressure. Consequently much more of these two undesirable components would be absorbed at high pressure than at low. This would result in much heavier loads on the reabsorber, still condensers, recompressor, and would tend to increase the loss of propane in the de-ethanizer overhead.

Volatilities Increase

On the other hand, a point in favor of refrigeration is the fact that the relative volatilities of methane and ethane with respect to propane *increase* with lowered temperature. Fig. 12 shows the effect of temperature and pressure variation on the relative volatility of methane with respect to propane. Curve A gives the relation between relative volatility and temperature for a constant pressure of 200 psia, whereas B relates volatility and pressure at a constant temperature of 110°. The pressure and temperature scales are so located that any ordinate represents a point of equal propane K for both curves; (decreasing the temperature at 200 psia from 110° to 57° has the same effect on the K of propane as increasing the pressure at 110° from 200 to 500 psia). The curves show the marked difference in the effect of temperature and pressure variation on relative volatility. The absorber will be much less selective at high pressures than at low temperatures; at high pressures more methane will be absorbed for a given absorption of propane.

A final point in favor of refrigeration: if a refrigeration plant is to be installed anyway, it may be conveniently expanded to include the chilling of de-ethanizer reflux, thereby saving a considerable amount of propane otherwise lost in the de-ethanizer tops. For example, the methane, ethane, and propane content of the raw gasoline feed to the de-ethanizer may be in the following proportions:

Methane	10 mols
Ethane	20 mols
Propane	70 mols

Assuming 450 psig operation, it may be calculated that only 79% of propane in the feed may be recovered with reflux at 90°, but that this recovery may be increased to 92% by reducing the reflux temperature to 60°. (Basis: MIT K's; the small amount of ethane in the bottoms is ignored in this calculation). The application of refrigeration to the de-ethanizer in this case easily pays for itself in terms of propane saved.

The factor governing the permissible depth of refrigeration is hydrate formation. Hydrates are slushy hydrocarbon masses which foul risers, downcomers, and heat exchange equipment, and which are likely to make their appearance at 50 to 70° in high pressure absorbers where sufficient water is present. (See chart in Natural Gasoline Supply Men's Association Technical Manual for relation between temperature, pressure, and gas gravity in hydrate formation.) Lower temperatures may be made possible by installing appropriate dehydration apparatus to remove water from the incoming wet gas and absorption oil.

The proper location of points of heat removal from the absorber raises several problems of judgment. Ideally an absorber would contain cooling coils on every tray in order to obtain maximum heat removal with minimum depth of refrigeration, but in practice only two or three chillers are used, these being located outside the tower. The reason for this is twofold: (a) the cost per square foot of heat exchange surface is greater for many small units than for two or three larger ones; (b) internal coils are difficult to service. The oil chillers may be located either on the ground or mounted on the tower. Placing them on the ground makes them convenient for servicing, but has the disadvantage of increasing the pressure drop between oil outlet and inlet nozzles.

Wet Gas Chiller Desirable

Since the mass of wet gas entering a high pressure absorber is likely to be comparable to the mass of lean oil entering, a wet gas chiller is usually desirable. In addition to providing a lower absorption temperature, this chiller will usually condense a substantial amount of propane and heavier which otherwise would have to be absorbed in the tower. This effect should be taken into account when calculating the absorber operation.

It is not usually desirable to chill lean oil prior to entry into the absorber since this would have the effect of discharging residue gas at a low temperature with a consequent loss of refrigeration. Operating the top of the tower at a higher temperature than the base does not seriously affect the extraction characteristics of the tower as a whole. The top trays of any absorber are chiefly devoted to absorbing those components lighter than the key component. This means that for a tower recovering a high percentage of propane, relatively little propane and heavier is absorbed on the top trays.

The absorber shown in Fig. 9 is refrigerated according to the principles just discussed. Two oil chillers are shown, located on the ground, and withdrawing oil from points along the column. A wet gas chiller

is also included. Lean oil is cooled by water, as usual, but is not chilled.

Because oil refrigeration is usually applied to existing plants, the problem frequently arises of how to adapt an existing absorber to refrigerated oil service. In general it is impractical in such cases to withdraw oil from points along the column. The head of oil required to drive it through a chiller and piping necessitates much greater tray spacing at these points than elsewhere, and the entire absorber would have to be re-trayed. (Of course, if the absorber needs re-traying anyway this doesn't apply.)

On the other hand, chilling lean oil prior to entry into the column will result in a loss of refrigeration due to the low temperature of residue gas. Such a loss might, of course, be prevented by installing a gas heat exchanger exchanging between cold residue and warm incoming wet gas, but such an exchanger would have to be unmanageably large because of the small temperature approach and low heat transfer coefficient between gases. Perhaps the best solution to this problem is the installation of a short absorber as shown in Fig. 13. Residue from the main absorber is processed in this small absorber and partially enriched oil from the latter is pumped into the main absorber.

This arrangement provides, in effect, an intercooled absorber. Not only does it provide additional absorption trays (very desirable for high extraction problems where the main absorber only contains 16 or 18 trays), but it also serves to capture the "coldness" in the residue gas from the main absorber, residue leaving the small absorber at a considerably higher temperature. It is suggested that the small absorber contain six to eight trays.

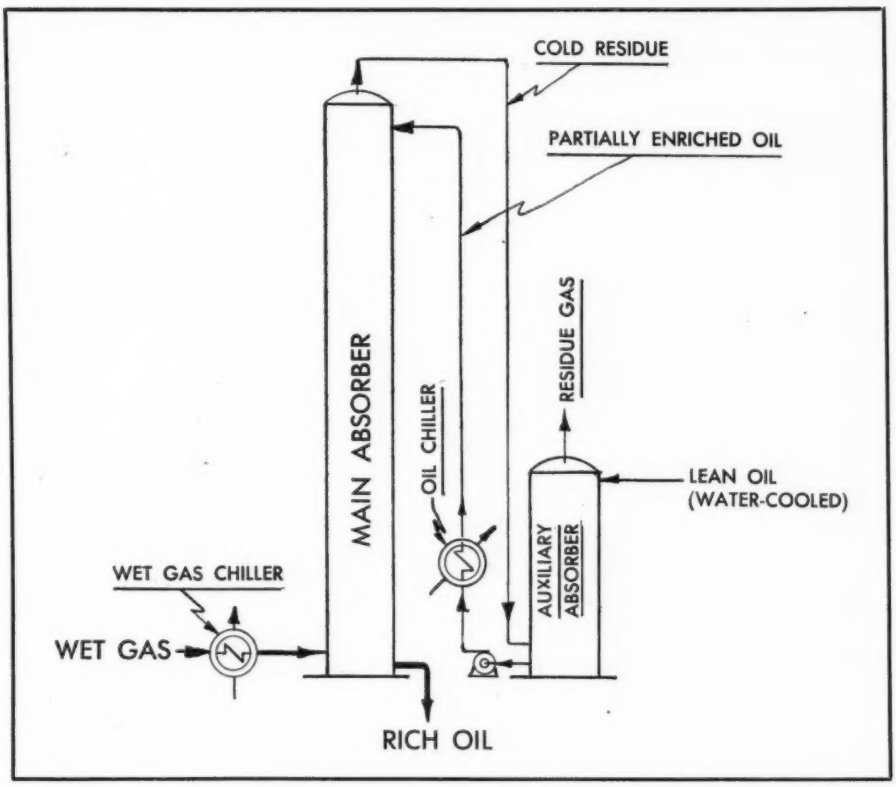


Fig. 13—Main absorber with small auxiliary absorber

Calculation Difficulties

The refrigeration load is determined by a heat balance around the absorber, performed after some desirable bottom temperature has been set. Perhaps the most difficult problem concerning this heat balance is the matter of estimating the residue gas temperature. In high pressure absorbers where the mass throughput of gas may be comparable to that of oil, a few degrees one way or the other in the choice of residue exit temperature may make a very substantial difference in the computed refrigeration load. Unfortunately there is no convenient way of mathematically determining just what this residue gas temperature will be and it must be arrived at on the basis of past experience.

The temperature gradient through an absorber varies drastically with pressure, gas composition, and extraction rates. In low pressure units, virtually all the heat of absorption will be taken up by the oil and the residue will issue at about the same temperature as the incoming lean oil. At very high pressures exactly the opposite is likely to be true. The authors have observed an absorber operating at 1800 psig in which lean oil entered at 98° and *cooled down* to 90° at the bottom! Unfortunately no readings were available on the residue gas line, but judging from its warmth, residue must have left the tower at 115° or higher. The choice of residue gas temperature in design problems is therefore a matter of judgment. At moderately high pressures (say 200 to 600 psig) it is suggested that the residue be set at 5 degrees above the incoming lean oil. At higher pressures somewhat higher residue temperatures may be used, up to perhaps 10 degrees above lean oil for very high pressure problems of the type described above.

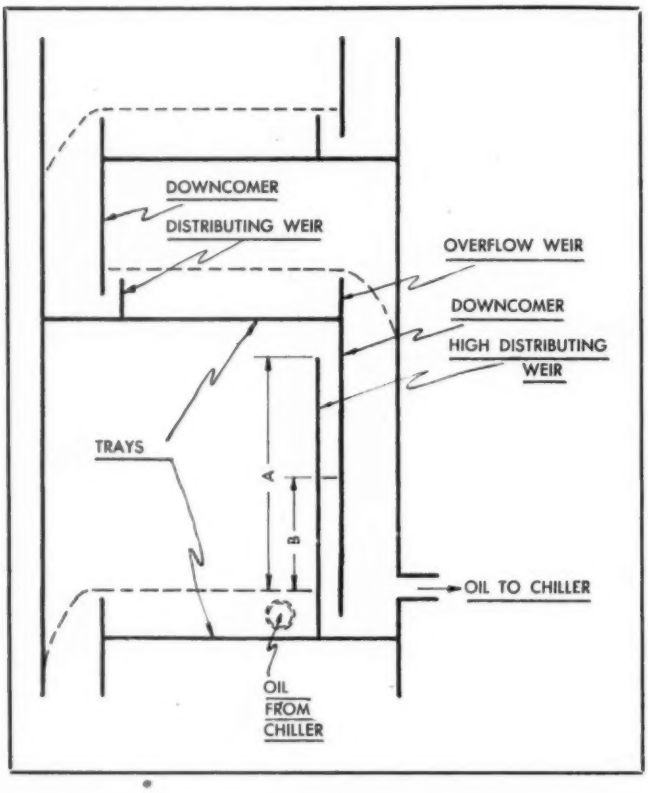
The proper location of oil drawoff points along the column is another problem for which there is no conveniently accurate solution. In general it is satisfactory to space them equidistantly. For instance, two drawoff points on an 18 tray absorber would be located at the sixth and twelfth trays. In case of doubt, an indication of the proper locations may be obtained by means of a tray-by-tray study of the absorber, followed by plotting the distribution of heat of absorption along the tower. The chilling points should be so located that the total chilling load is approximately equally distributed among the chillers.

Allowance for Pressure Drops

Special care should be exercised in making allowance for pressure drops through lines and chillers or they may become bottlenecks. It is recommended that the trays at drawoff points be so spaced that the head of oil available to overcome drops through lines and chiller be twice the head theoretically required. Fig. 14 shows the proper design of an oil drawoff point. A very high distributing weir is shown, the purpose of which is to bypass oil around the chiller if, for any reason, the latter were to become blocked. The height of this weir determines the maximum head available, *A*. *B* indicates the theoretically required head and should be half of *A*. *B* includes not only the head loss through the lines and chiller, but also the head loss of vapor passing through the risers (not shown) and liquid on the tray above.

In computations concerning required oil circulation, it is recommended that the method of Sherwood[2] be used. The accuracy of this method is slightly affected by the irregular temperature gradient of a refrigerated tower, but it is nevertheless the most convenient for this type of problem.

A flow diagram of a refrigeration system appropriate for the chilling



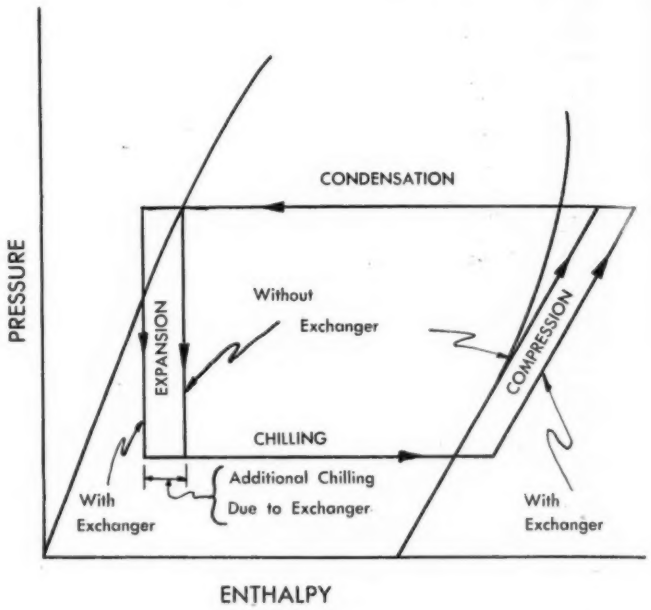
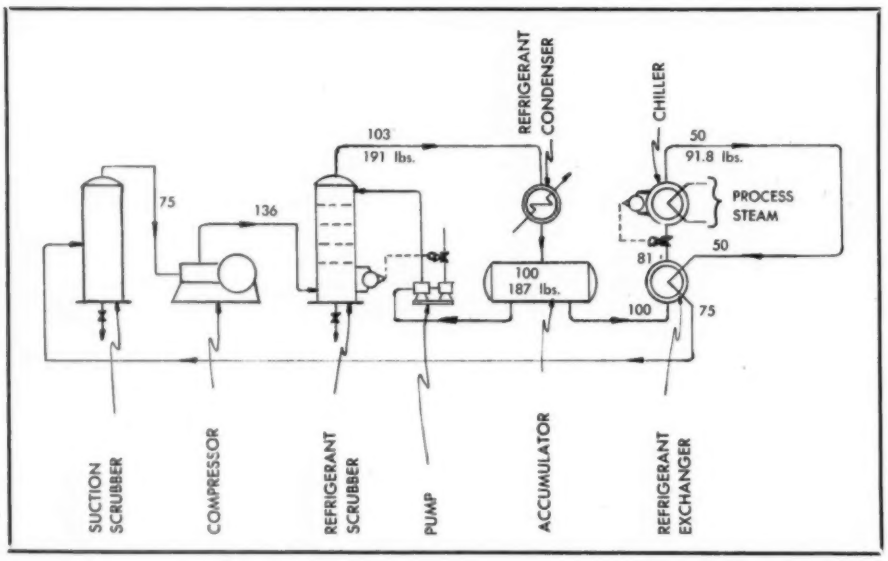


Fig. 14—Left above: Absorber oil drawoff point

Fig. 15—Left below: Propane refrigeration system

Fig. 16—Right above: Effect of refrigerant exchanger on refrigeration cycle



of the absorber and de-ethanizer is shown in Fig. 15. The diagram is complete except that only one chilling unit is shown, the others being attached in parallel with the one shown. For most natural gasoline plant purposes, propane is the most suitable refrigerant; it is readily available as one of the plant products and it does not require an extreme operating pressure. Butane may be used for moderate depths of refrigeration, but care must be exercised in designing butane systems because of the possibility that some part of the system may run under vacuum with a consequent danger of inward leaks.

The general outlines of the system are simple: liquid propane from an accumulator is expanded through a valve and evaporated in the chiller; the resulting propane vapor is compressed and recondensed in a water cooled condenser. Typical temperatures and pressures are indicated. Two points of special interest should be noted:

(a) A refrigerant exchanger is shown, subcooling liquid prior to expansion and slightly superheating the vapor prior to compression. This exchanger serves two general purposes. First, by supplying superheated vapor to the compressor, it helps forestall condensation on the cylinder walls. Secondly, it appreciably improves the efficiency of the refrigeration cycle. This latter effect may be clarified by a brief study of Fig. 16. The heat removed from propane liquid in the exchanger results in a corresponding increase in the amount of refrigeration that the propane liquid will do upon expansion. This will be accomplished with relatively little increase in work input since compression will be approximately isentropic, and the constant entropy lines are practically parallel. Part of the gain will, of course, be nullified by pressure drop through the exchanger (not shown in Fig. 16) but the overall gain is considerable.

(b) A propane scrubber containing a few trays is also shown. A small liquid propane stream from the accumulator is injected near the top of this scrubber, contacting superheated vapor from the compressor. The quantity of this stream is just sufficient to bring the compressed vapor down to saturation. The effect of this action is twofold. First, engine oil and other heavy hydrocarbon ends which, if allowed to remain, would foul the exchange equipment, are washed down and may be drained from the base of the scrubber. Secondly, by presenting a saturated vapor to the condenser, there is effected a considerable saving of surface that would otherwise be devoted to removing superheat at a low heat transfer coefficient.

(1) Kirkbride, C. G., *Pet. Refr.*, 23, 321 (1944); and Bolles, W. L., *Pet. Refr.*, Dec., 1946.

(2) Sherwood, T. K., "Absorption and Extraction," Chap. IV, McGraw-Hill, 1937.

Handling Sulfur Compounds in Refining Is Program Topic for ACS Meeting

RESULTS of experimental work to find methods for the removal of objectionable sulfur compounds from oils during the course of processing high-sulfur stocks will be presented at the 1949 spring meeting of the Petroleum Division of the American Chemical Society, in San Francisco, March 28-April 1.

Another important feature of the meeting will be a Symposium on Micro Chemistry, to discuss new techniques in the type of laboratory analytical work where only exceedingly small amounts of material are to be handled.

The increasing processing of high-sulfur crudes the past few years has resulted in more attention being given in oil company laboratories to methods for handling such stocks in the course of refining, as well as for treating finished products. Following are examples of a few reports on this subject to be given at the Symposium on Sulfur Compounds.

Experimental work will be reported as carried on by Standard Oil Co. (Ohio) in the hydrosulfurization of heavy oils to reduce their sulfur content to the point they can be handled in conventional refinery equipment. The hydrosulfurization of several high-sulfur gas oils and a high-sulfur reduced crude was done at mild operating conditions, using cobalt oxide-molybdena-alumina compositions as catalysts.

A paper will be presented on work done at the Bureau of Mines experimental station at Bartlesville on treating high-sulfur crudes in a bauxite catalytic desulfurizer. The experiments have indicated that not only can the amount of sulfur be reduced by such treatment but additional amounts of upgraded gasoline can also be secured.

The sulfur content of catalytically cracked gasolines will be discussed in a paper on work done in the Riverside laboratories of Universal Oil Products Co., based on processing a variety of feed stocks in pilot plants. The relationship was studied of the effect of feed stock origin, its sulfur content and certain operating variables on the sulfur content of the gasolines produced.

A report from the Shell Development Co. laboratories will discuss a process for the hydrodesulfurization of the catalytically and thermally cracked gasoline fractions by controlled hydrogenation over a commercial tungsten-nickel sulfide catalyst.

Dr. W. E. Kuhn, manager, Technical and Research Division, The Texas Co., and chairman of the Petroleum Division of the American Chemical Society

Another paper will discuss the sulfur distribution in the thermal cracking of high-sulfur feed stocks. Sulfur contents in the charge stocks and in gasolines from various domestic and foreign crudes were studied, and a factor was developed for predicting the sulfur content of thermally cracked gasoline from the sulfur content of the charge stock. This work was done in the Port Arthur laboratories of The Texas Co.

The treatment of refinery acid sludges to recover elemental sulfur and coke is the subject of a paper discussing work carried on at Ohio State University.

Another report from the Shell Development laboratories will discuss the efficiency of alkyl phenols as solutizers in the extraction of mercaptans with caustic soda solutions.

Socony-Vacuum Oil Co. Inc. research workers will present a paper on their work on the chemistry and synthesis of thiophenes and the methods for their removal from coal tar and petroleum stocks.

The influence of impurities and the effects of various gases on the selectivity of cracking catalysts at high temperatures has been studied in the Houdry Process Corp. laboratories and the results will be presented at the San Francisco ACS meeting.

The laboratories of the California Research Corp. ((Standard of California) have done work on the desulfurization of thermally cracked naphthas with hydroforming catalysts. Vanadia - alumina and molybdena-alumina catalysts were compared for the desulfurization and reforming under hydroforming conditions, the results to be given in a paper at the ACS symposium.

From the Baton Rouge laboratories of Esso Standard Oil Co. will come a report on work done on the desulfurization-hydrogenation treatment of high-sulfur catalytically cracked cycle stocks.

Results are also to be given on work done at the Universal Oil Products Co. laboratory on the effect of sulfur compounds on the storage stability of fuel oils. It was concluded that the selection of a treating process to improve the odor must also take into account the effect of the process on the stability of the oil. Doctor sweetening was said to be unsatisfactory and, while caustic washing will remove thiophenols, it will not remove high molecular weight mercaptans. Caustic-methanol extraction was said to appear promising as a means for actual removal of the mercaptan sulfur compounds.

Others among the 30 papers to be presented at the Symposium on Sulfur Compounds will cover the occurrence, identification and analysis of such compounds in petroleum, their effect on metals and on the properties of refined products. This portion of the program is in charge of Dr. A. A. O'Kelly, associate director of Socony-Vacuum's Research and Development Department, and vice chairman of the ACS Petroleum Division.

The Symposium on Micro Chemistry will include micro physical techniques, micro chemical analyses and syntheses, training of microchemists and so on. Chairman of this portion of the program will be Harry Levin, supervisor of the Analytical and Testing Department, Beacon Research Laboratories, The Texas Co. Nearly a dozen papers on a wide variety of subjects will be presented at the general session of the program, at which the presiding officer will be Dr. W. E. Kuhn, manager of the Technical and Research Division, The Texas Co., the chairman of the ACS Petroleum Division.

ECONOMIC COMPARISON

Petroleum and Coal as Energy Sources

By ROBERT L. RORSCHACH
Consulting Engineer, Tulsa

THE BASIS OF MODERN CIVILIZATION is energy, to produce and transport the material things required by today's standard of living. The progress of man toward higher levels of technology and ever greater numbers of comforts and conveniences has been marked by a regular increase in the per capita expenditure of energy. In the U. S. this per capita expenditure has risen from 105.5 million Btu. in 1900 for a population of 76 million to 240 million Btu. in 1947 for 143 million people.

Today the two outstanding sources of energy in the U. S. are coal and petroleum, together accounting for 95% of the total power consumption. Figure 1 and Table 1 show the energy production in this country since 1900, and also the proportions contributed by coal, oil and natural gas. The rapid increase in power from petroleum is significant and explains why a relative oil shortage has existed until the past year, although supplies exceed those of World War II.

Oil and gas have furnished nearly all the additional energy generated in the U. S. since 1920, and with good reason. The remarkable increase in quantity and efficiency of petroleum production over the past 25 years contrasts sharply with the decline and uncertainty of the coal supply. Table 2 presents U. S. Bureau of Mines statistics on production of energy resources over that period. In addition, petroleum's low price per energy unit, while higher than in past years, is still economically competitive with that of coal. As of February, 1948, One Dollar would buy 3.63 million Btu. of coal energy, 6.67 million Btu. of natural gas energy, or 2.60 million Btu. of fuel oil energy. (Table 3). In the case of coal used for power purposes the cost of the disposal of ashes and the cost of firing must be taken into account.

Assurance of an adequate fuel supply has been of considerable economic importance and has played a large part in the increased use of petroleum fuels, particularly in the last few years of strikes and labor unrest in solid fuel production.

Finally, the convenience and cleanliness of petroleum fuels appeal to everyone, particularly the homeowner who appreciates the automatic temperature regulation possible with oil or gas without the ashes and soot associated with coal.

In 1948 more petroleum was produced in the U. S. than ever before, 5,325,000 barrels per day, but requirements have also greatly expanded. Motor vehicle registration has increased more than 2 million since 1941, while the number of farm machines has practically doubled and

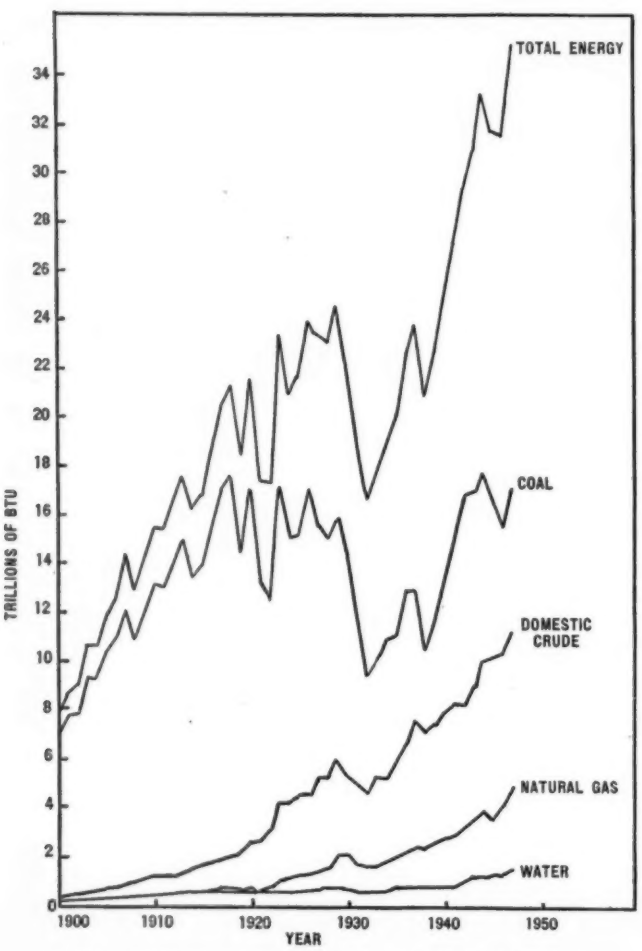


Fig. 1—Energy production in the United States

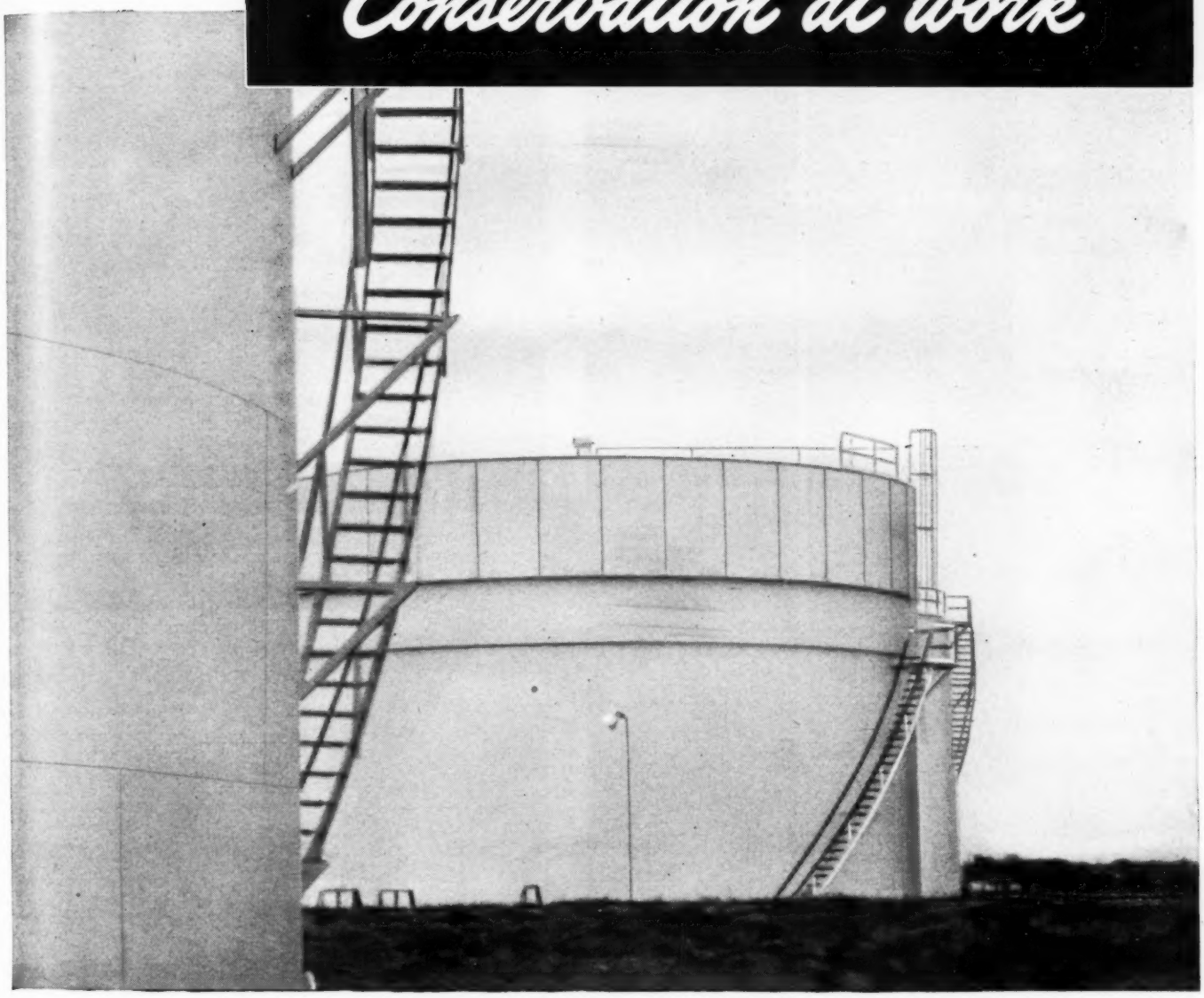
TABLE 1—Energy Production in the U. S.

(Figures in Trillions of Btu.)

Year	Coal	Domestic Crude	Natural Gas	Water	Total
1900	7,123	382	254	250	8,009
1901	7,752	416	283	264	8,715
1902	7,943	533	301	289	9,066
1903	9,437	603	319	321	10,680
1904	9,291	702	333	354	10,680
1905	10,367	808	377	386	11,938
1906	10,942	759	418	414	12,513
1907	12,671	997	437	441	14,546
1908	10,978	1,071	432	476	12,957
1909	12,155	1,099	517	513	14,284
1910	13,226	1,257	547	539	15,569
1911	13,096	1,323	551	565	15,535
1912	14,088	1,338	604	585	16,615
1913	15,025	1,491	626	609	17,751
1914	13,545	1,595	636	636	16,412
1915	14,018	1,687	676	659	17,040
1916	15,548	1,805	810	681	18,844
1917	17,166	2,012	855	700	20,733
1918	17,868	2,136	775	701	21,480
1919	14,602	2,270	802	718	18,392
1920	17,336	2,658	858	738	21,590
1921	13,358	2,833	712	620	17,523
1922	12,551	3,345	820	643	17,359
1923	17,331	4,394	1,083	685	23,493
1924	15,064	4,284	1,228	648	21,224
1925	15,306	4,582	1,278	668	21,834
1926	17,319	4,625	1,411	728	24,083
1927	15,744	5,407	1,553	776	23,480
1928	15,169	5,409	1,686	854	23,118
1929	16,025	6,044	2,062	816	24,947
1930	14,136	5,388	2,089	752	22,365
1931	11,633	5,106	1,813	668	19,220
1932	9,470	4,711	1,673	713	16,567
1933	10,089	5,434	1,672	711	17,906
1934	10,970	5,448	1,904	698	19,020
1935	11,175	5,980	2,060	806	20,021
1936	12,989	6,598	2,330	812	22,729
1937	13,083	7,675	2,588	871	24,217
1938	10,387	7,286	2,468	866	21,007
1939	11,745	7,590	2,663	830	22,836
1940	13,472	8,119	2,860	880	25,331
1941	15,004	8,413	3,024	934	27,375
1942	16,908	8,320	3,282	1,136	29,646
1943	17,113	9,034	3,671	1,304	31,122
1944	17,966	10,067	4,064	1,301	33,398
1945	16,576	10,267	3,662	1,399	31,904
1946*	15,600	10,500	4,200	1,400	31,700
1947*	17,400	11,300	5,000	1,600	35,300

* Estimated.

Conservation at work



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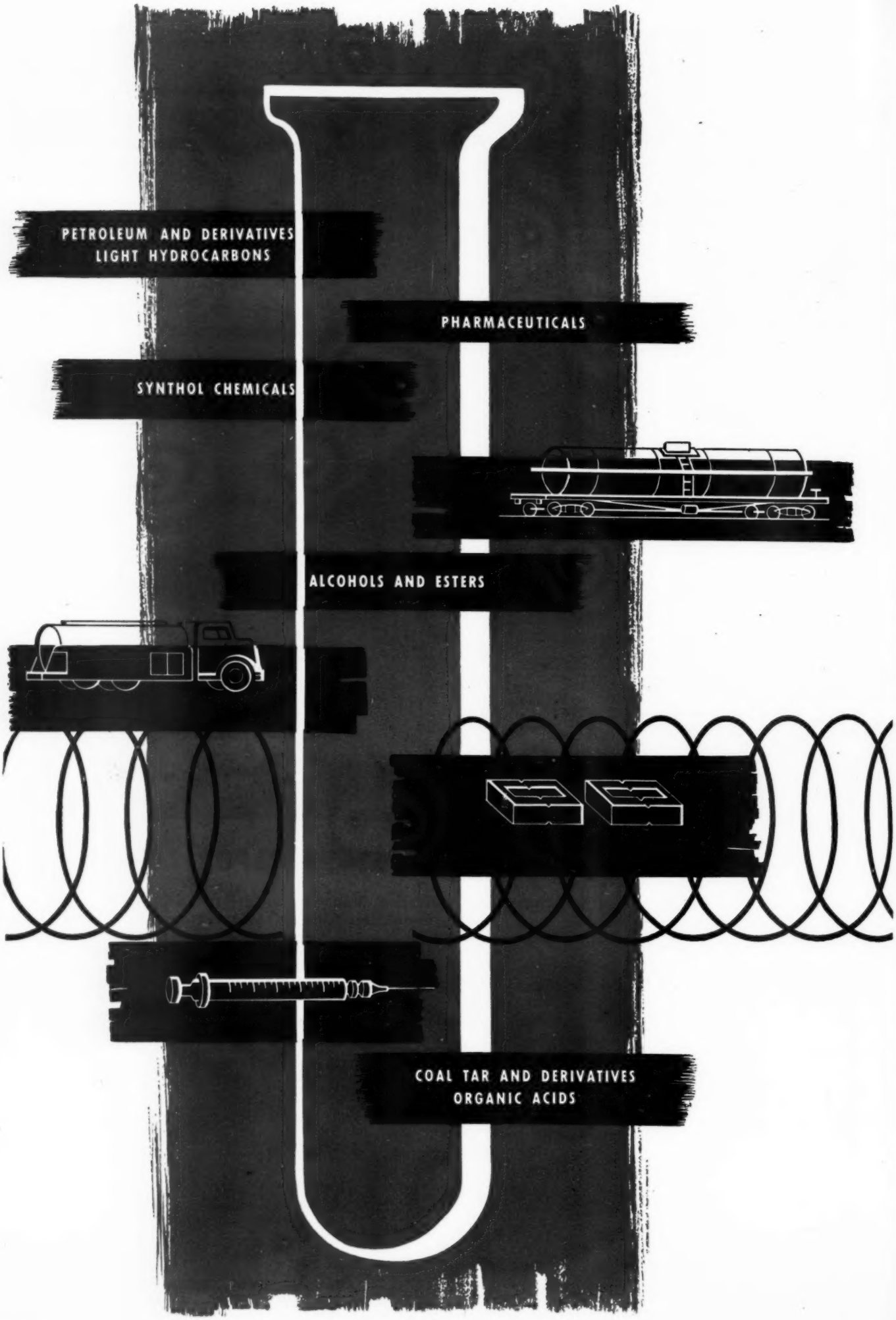
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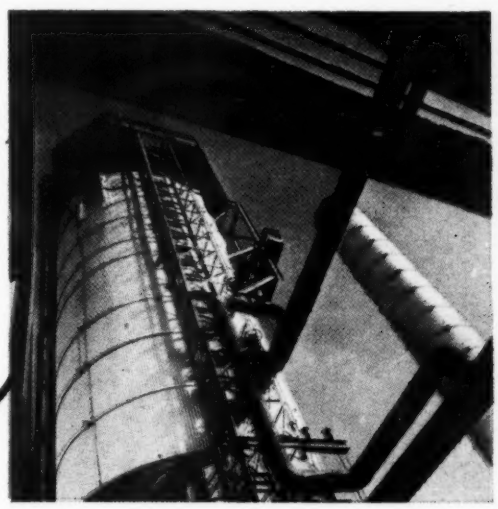

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PROCESS ENGINEERS AND CONSTRUCTORS FOR THE CHEMICAL, PETROLEUM AND PETRO-CHEMICAL INDUSTRIES

TABLE 2—Production of Energy Resources in the U. S.

	1920	1941	1946
Coal (millions of tons)	658.2	570.5	593.0
Crude oil (millions of bbls.)	442.9	1402.2	1733.0
Natural gas (billions of cu. ft.)	798.1	2812.7	3900.0

the use of liquefied petroleum gas in homes and industries has jumped 208% over the same period. A rapid shift from coal to oil for heating has taken place and European demands on U. S. petroleum products have been very heavy. To meet this unprecedented demand the petroleum industry increased production by one-third over 1941 figures in the face of steel shortages which today prevent even further expansion.

Despite record-breaking consumption and production, proven reserves in the U. S. are today greater than at any time in the past. On this point, however, the coal industry is at an advantage. Although petroleum generates as much U. S. energy as coal, reserves are estimated in years, while coal reserves are measured in centuries. Oil, best suited for use in transportation and as a lubricant, is being too rapidly consumed as fuel for stationary industrial equipment and for heating.

Notwithstanding the greatest demand in history, and highly inflated costs of production, prices of petroleum products are lower and have advanced less than that of any other commodity. Figs. 2, 3 and 4 show the price history of coal and petroleum fuels since 1926. In 1947, for the first time in 20 years, the petroleum price index reached 100. Other prices broke through that level at the start of the war and are still spiralling higher.

Indicative of the petroleum industry's enterprise and progressiveness is its 50 million dollar yearly budget for research to discover new products and improved methods. The expenditures of the coal industry amount to 15 million dollars. A dozen or more oil companies are actively investigating the production of synthetic liquid fuels from natural gas, while one coal company, in co-operation with an oil company is conducting research of a similar nature on coal.

In addition to steel shortages, rising costs and overwhelming demand, the petroleum industry must contend with increasing efforts of government to extend its control over the oil business. Because of the tight supply situation, rising prices, and a lack of proper publicity on what the industry has done, a certain amount of public sentiment has arisen in favor of federal petroleum controls. This, of course, is not the solution. It has been proven many times over that government is unable to match private enterprise in initiative and efficiency. For a short term increase in production, the petroleum industry requires more steel and less government interference. For long term conservation of resources, the country requires more production and efficiency from the coal industry so that it can assume its fair share of the energy production burden.

TABLE 3—Energy Per Dollar

(Millions of Btu.)

Year	Coal	Fuel Oil	Natural Gas
1948	3.63	2.60	6.67
1941	5.91	10.00	8.33
1926	6.16	5.00	6.55

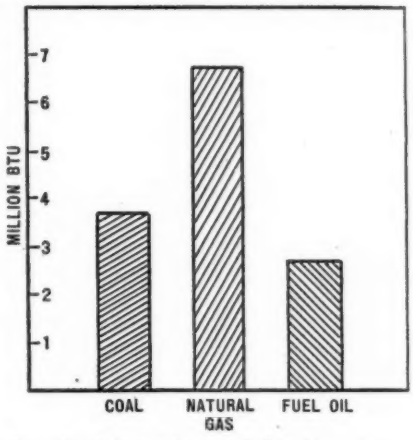

Fig. 3—Comparison of buying power of One Dollar for million Btu. of coal, gas, and fuel oil—February, 1948

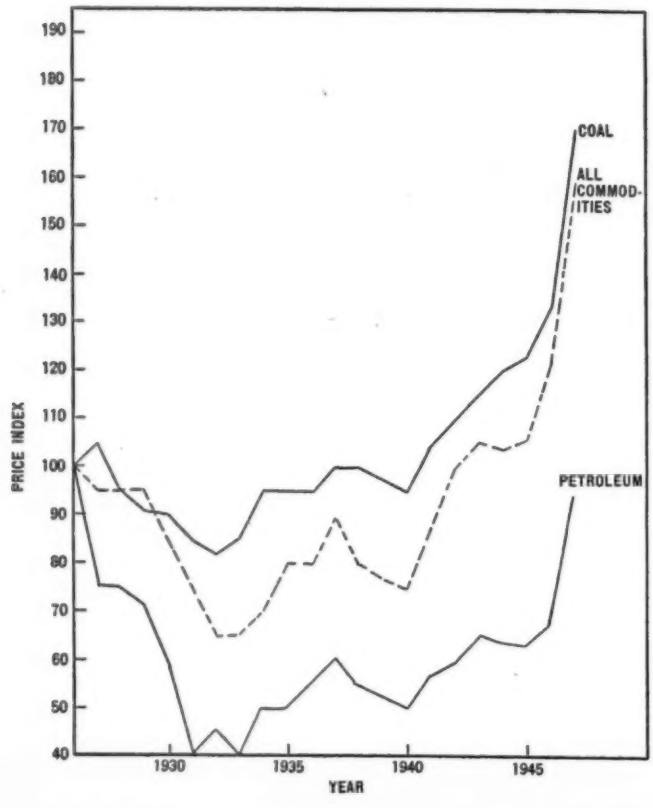

Fig. 2—Index of wholesale commodity prices: 1926 = 100

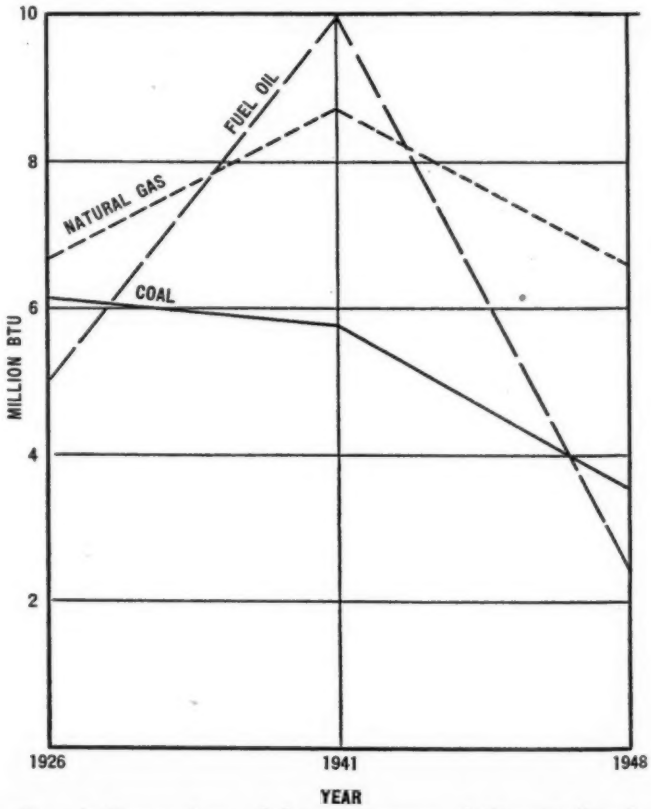

Fig. 4—Comparison of buying power of One Dollar for million Btu. of coal, gas, and fuel oil

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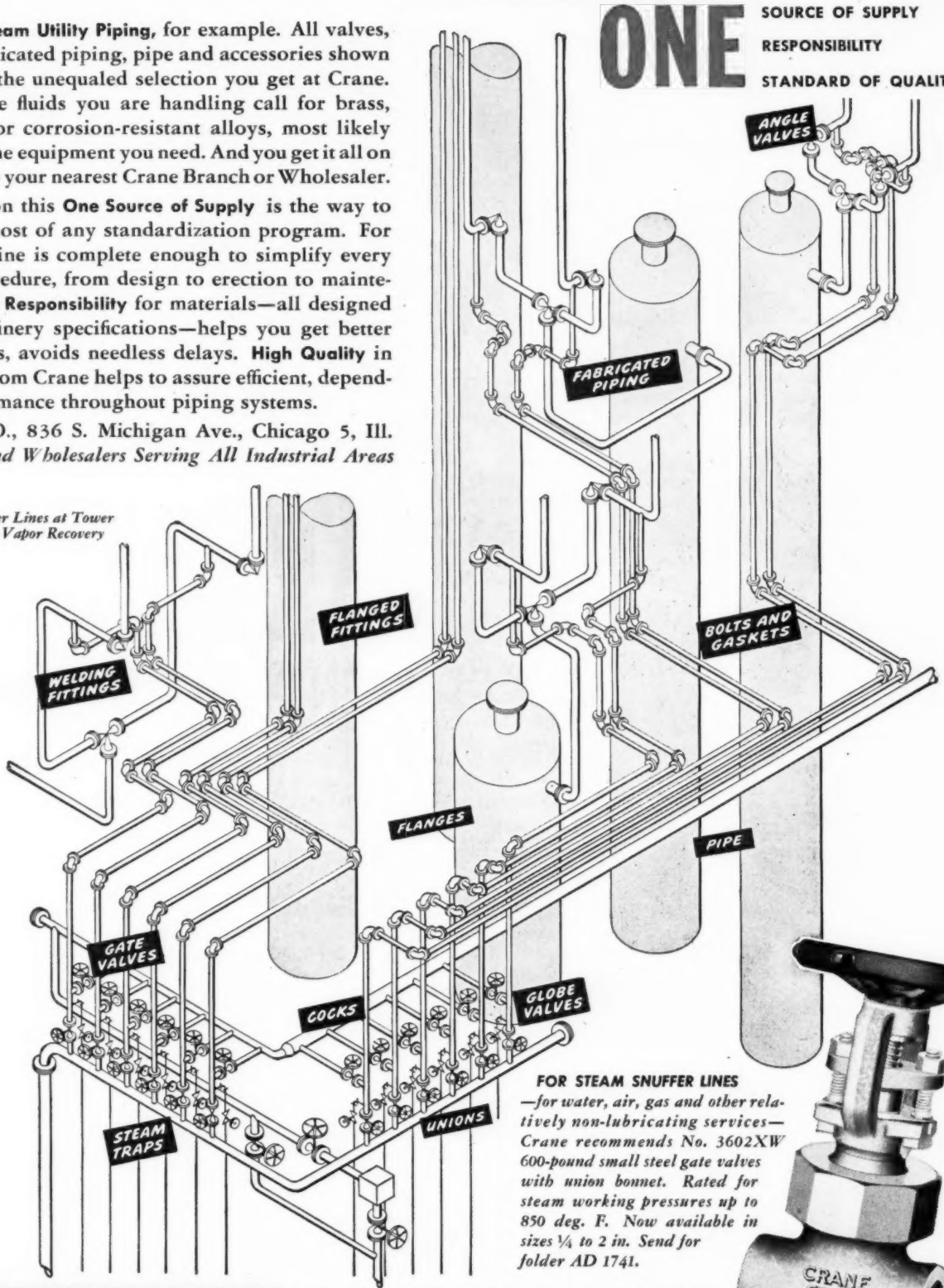

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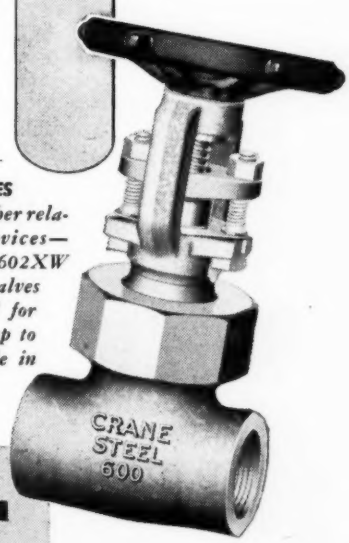

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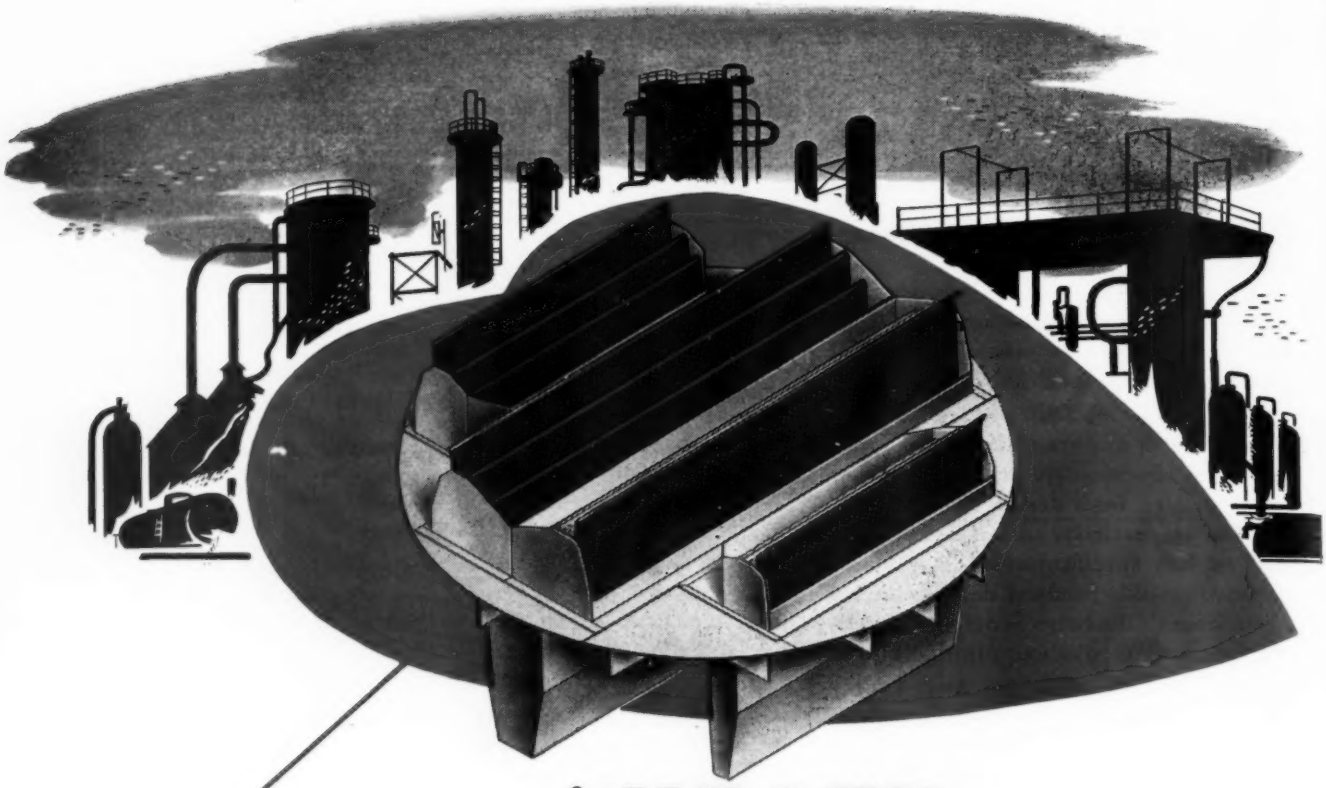

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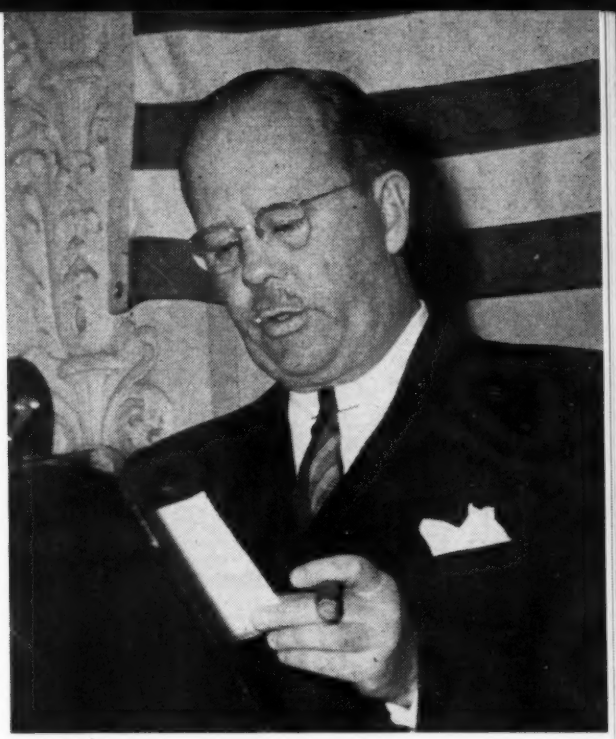


H. T. Ashton, Manager, Central Marketing Region, Socony-Vacuum Oil Co., Inc., President of Western Petroleum Refiners Assn.

BETWEEN 750 and 1000 refiners and supply men are expected to attend the annual meeting of the Western Petroleum Refiners Assn., which convenes March 28-30 at the Plaza Hotel in San Antonio, according to John C. Day, WPRA Secretary. As yet arrangements for the general program are not complete, but it is expected to emphasize the supply and demand picture, agricultural requirements and possibly equipment availability as reflected by the steel situation.

There will be five technical papers, arranged for by Mr. Day and the association's Manufacturing Committee, of which R. R. Irwin, White Eagle Division, Socony-Vacuum Oil Co., Kansas City, is chairman. One session, sponsored by the Motor Fuel Committee will cover motor and Diesel fuels, including various technical committee activity reports. To be presented at this session also is a paper by N. H. McLaurin, C. H. McIntosh and D. S. Kaufman, all of The Texas Co. entitled "Hydroforming and Thermal Reforming Operations on Sweet and Sour Heavy Straight-Run Naphthas." Chairman of this session will be Miller W. Conn, Perco Division, Phillips Petroleum Co., Bartlesville.

John C. Day, secretary-treasurer, Western Petroleum Refiners' Assn.

The morning session March 29 will have John Pfarr, Leonard Refineries, Inc., Alma, Mich. presiding. Three papers will be presented, followed by discussion. "Houdriflow Catalytic Cracking" will be described by a representative of the Houdry Process Corp., Philadelphia, followed by two papers by representatives of the U. S. Air Forces. The first is "Development of Fuels and Lubricants for Jet-Propelled Aircraft," by Capt. Leslie G. Pattillo, Air Materiel Command, Power Plant Laboratories, Wright-Patterson Air Force Base, Dayton, O.; the second, "Research and Development of Special Petroleum Products for the Air Force" by Lt. Col. H. A. Messman, also from the Wright-Patterson base.

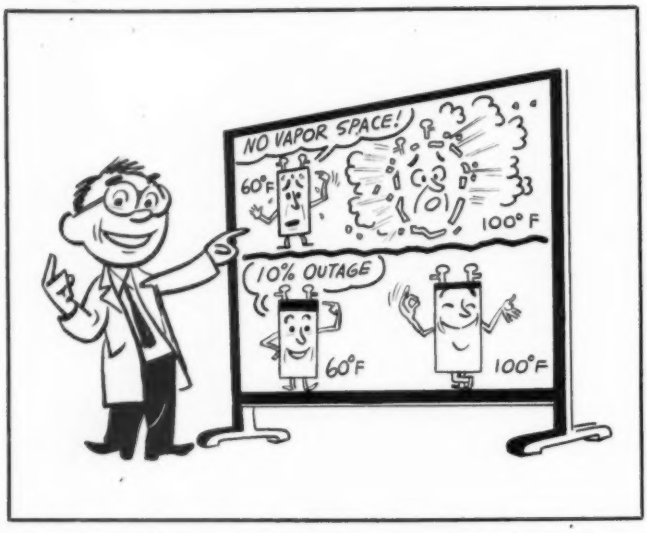
The final technical session of the WPRA meeting, the morning of March 30, will have as chairman Baxter I. Scoggin, Anderson-Prichard Oil Corp., Oklahoma City, and features two papers. The first is entitled "Trends in the Refining Industry," by E. F. Nelson, Universal Oil Products Co., Chicago, and the second, "Laboratory and Drum Storage Stability of Thermally and Catalytically Cracked Fuel Oils," by R. O. Bender, Organic Chemicals Dept., Technical Division, E. I. du Pont de Nemours & Co., Wilmington.

Abstracts of Papers

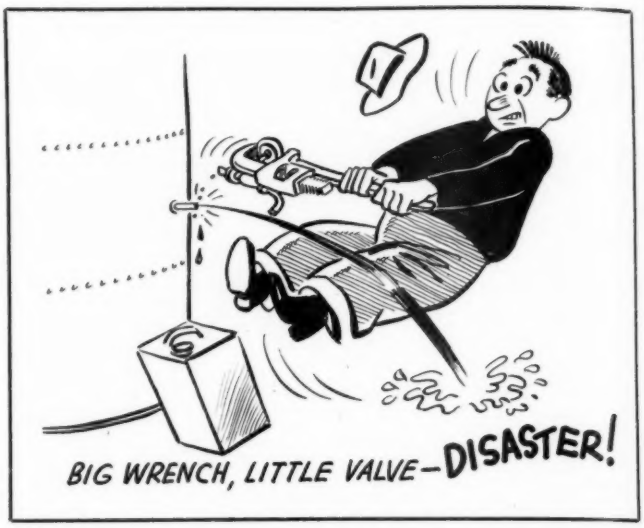
The paper on refining industry trends is expected to cover the entire field of refining with the possible exception of lubricant manufacture. Under refinery modernization the subjects to be treated include processing means for: Increasing octane number, especially by the research method; meeting the increased demand for Diesel and distillate fuel oils; handling increased demand for liquefied petroleum gases; utilizing fractions "freed" by the reduced demand for residual fuel oils; the processing of greater quantities of high-sulfur supplementary crude supplies, with special emphasis on such substitute crudes as that recovered from shale oil; and the production of chemical raw materials. Various processes to be discussed will be illustrated by slides.

The principal chemical changes which may occur when distillate fuel oils are stored are outlined in the paper on storage stability of thermally and catalytically cracked oils and the possible effect of these changes on the usefulness of the fuels is discussed. Methods for measuring the solvency of a fuel for its deterioration products and the importance of this property are described. Data will be presented showing the variations in solvency with fuel type and conditions of aging. Effects of copper, water and tank bottoms is shown for two fuels stored outdoors in drums. The paper emphasizes the need for further studies of test methods and factors affecting storage life.

Results from hydroforming and thermal reforming operations on both sweet and sour heavy straight-run naphthas will be included in the paper by technologists of the Texas Co., which will be presented by Mr. McLaurin. The product distribution and yield-octane number relationships are compared. Hydroforming is shown to give a better yield-octane number relationship than thermal reforming. It is pointed out that reforming the sour stocks resulted in much higher octane number improvement than in reforming the sweet stocks. The paper concludes with comparison of the economics of the two processes on both stocks, based on direct operating costs and indicates there is relatively little difference in the two operations when the stocks are reformed to a given octane level.



Esso Standard Oil's special safety rules book for technical personnel contains a number of eye-catching cartoons, two of which are shown here. The drawing on the left



illustrates a rule covering the safe filling of a liquid sample container, the drawing on the right emphasizes the hazard in using a wrench of the wrong size

Safety Manual for New Technical Men

By K. O. JOHNSON
Technical Service Division
Esso Standard Oil Co.

VIRTUALLY ALL OIL COMPANIES are confronted with the problem of acquainting the new technical employee with refinery equipment and plant operation. Past experience has indicated this orientation program generally is most efficiently and quickly accomplished by assigning the new man to test work or some contact job which will allow him to see first hand the operation of the various refinery units.

Such procedure is potentially dangerous, however, because the new man knows little or nothing regarding individual refinery hazards. Furthermore, it is natural to expect that on his first job, he will endeavor to get his work done as quickly as possible so as to make a good impression on management. In this state of mind he would be prone to neglect the important step of taking time out to check on the safety regulations pertaining to the job; particularly, if these regulations are not readily available.

As a result, the man may take undue chances or may perform unknowingly some operation which could result not only in injury to himself and his fellow employes, but also in damage to valuable equipment and loss in production.

It has been found that personal talks with the new technical employee to acquaint him with the rules governing his safe conduct in the plant—proper procedure for gaging a tank, taking samples, etc—constitute a necessary first step in making him "safety conscious."

In line with this training program, a survey was made by Esso Standard Oil Co. to determine whether the existing refinery safety bulletins were suitable for use by the new technical man. The results of the survey indicated that although these publications were well written, they omitted several safety regulations which apply exclusively to the engineer's activities in the plant. Furthermore, the booklets generally covered all phases of refinery work, necessitating the inclusion of considerable information which seldom, if ever, applied specifically to the engineer. Therefore, it was difficult many times to "dig out" a regulation pertaining to some particular job the engineer was about to perform, thus tempting him to guess at the proper and safe procedure rather than spend further time seeking the correct information.

As an answer to this problem, the Esso Technical Service Division early this year published a booklet, "Refinery Safety for Technical Personnel," which serves as a means for finding quickly and easily the regulations pertaining to those jobs which the engineer encounters most frequently in the field.

In preparing the booklet, special emphasis was placed in making it readable. Regulations are stated as briefly as possible in large print. When necessary, a more detailed explanation follows in smaller print. Eye appeal is achieved by the use of two colors and several cartoons which illustrate some of the more important safety regulations. Comprising 32 pages, the booklet measures 4⅛ x 5⅜ in., a convenient pocket size.

The contents include the following sections: General Safety Precautions, Safety Precautions Preceding the Running of a Test, Safety Precautions Pertinent to Sampling Hydrocarbon Liquids or Gases, Special Safety Precautions for Process Areas where Corrosive Liquids are Used, and Safety Precautions Pertinent to Tank Gaging. In addition, the Appendix contains sections on Gas Mask Types and Uses, and First Aid Instructions.

Following are typical rules taken from the section dealing with sampling of hydrocarbons.

"1. USE PROPER TYPE CONTAINERS WHICH ARE IN SAFE CONDITION.

"Check all sample containers before use to see that they are of the proper type and in safe condition to use. Those having leaky valves or other faults should be returned immediately to the Instrument Department for repair.

"Clean glass bottles (1 gallon or smaller) or cans (1 and 5 gallons) may be used for oils having a vapor pressure of less than 15 psia. at 100° F. Samples having a vapor pressure of between 15 psia. and 35 psia. at 100° F. also may be taken in bottles or tin containers provided they are kept at a temperature less than 40° F. Samples having a vapor pressure above 35 psia. at 100° F. must be taken only in Safety Department ap-

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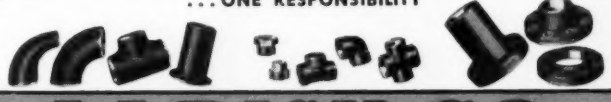

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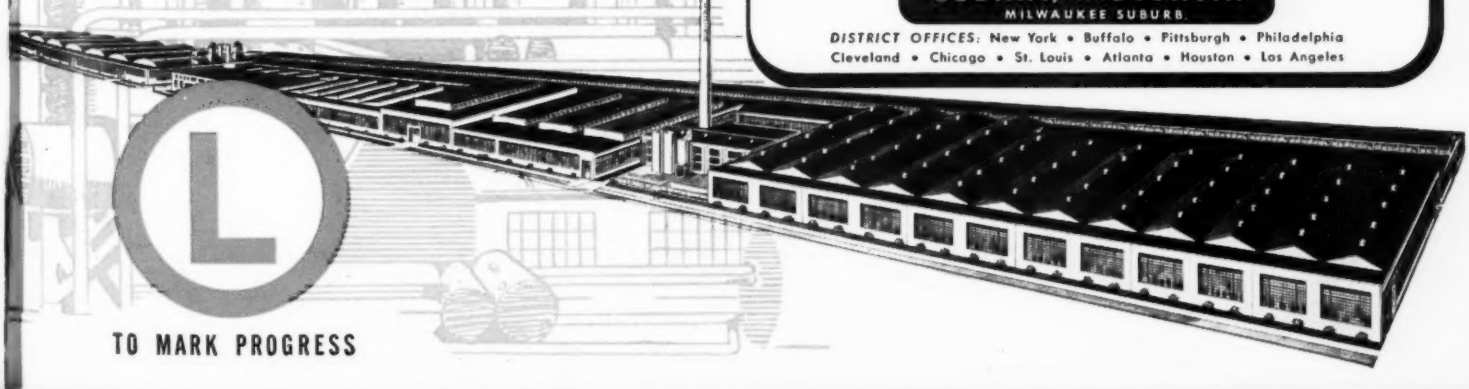

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proved metal bombs. If the sample is to be shipped by common carrier the container also must be I.C.C. approved."

"6. NEVER COMPLETELY FILL A LIQUID SAMPLE CONTAINER.

"All liquids, and especially light hydrocarbons, expand as their temperature is increased. If liquid sample containers are not provided with a vapor space above the liquid, sufficient pressure can develop to rupture with explosive force any of the standard type sample containers. It is recommended that the Interstate Commerce Commission regulations pertaining to vapor space in closed sample containers be closely followed, even if the sample is not to be shipped by common carrier. A safe general practice is to allow at least 10% outage for thermal expansion."

Following are typical rules from the section covering tank gaging:

"2. USE THREE MEN FOR GAGING SOUR STOCKS — TWO FOR SWEET STOCKS.

"Ascertain whether the stock in the tank is classified as 'sweet' or 'sour.' A sour stock is defined as one containing 0.05 cu. ft. or more H_2S per 100 gallons. 'West Texas Crude' is classified as sour regardless of the indicated H_2S content.

"In the case of sour stocks, the gager must put on and test his mask (see Appendix) when half way up the stairs to the tank (at the bottom of the stairs in the case of the run-down pans or shallow tanks). During the gaging the second man should be stationed approximately half way up the tank stairs in such a position that he can be of immediate assistance to the gager in the event of trouble. The third man shall serve as a watchman on the ground, and in case the gager is overcome will summon medical assistance while the second man administers first aid or artificial respiration.

"In the case of sweet stocks, one man shall gage and the other shall observe from the ground or stairway."

"4. AVOID DESCENDING TO THE ROOF OF FLOATING ROOF TANKS.

"Gaging of floating roof tanks shall be accomplished from the top stairway platform. If it is necessary to descend to the floating roof, you must obtain permission to do so from the head pump man or foreman, and the 'Floating Roof Tank Rules,' revised March 3, 1947, should be strictly adhered to. Under no circumstances is it permissible to descend to the floating roof if a tank contains a sour stock or a stock having a Reid vapor pressure of 12 lbs. or more. In the case of a sweet stock having less than 12 lbs. Reid vapor pressure, the tank may be gaged from the roof, but a safety watcher shall stand by on the top platform."

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PROCESSING REVIEW

Catalytic Cracking in 1948

By MARSHALL SITTIG
Chemical Engineer, Bangor, Maine

Recent technological developments in catalytic cracking as reviewed in the field of chemistry include new catalyst compositions and improved chemical methods of measurement of catalyst activities. In fluid mechanics, research continues in problems connected with fluid flow through beds of catalyst pellets, as well as in the phenomena of fluidization itself. Improvements and variations in the commercial catalytic cracking processes are reviewed.

THE DEVELOPMENT OF catalytic cracking in 1948 was marked by widespread building of new units based on existing processes, by the introduction of the Houdriflow process, the Thermofor Pyrolytic Cracking process (admittedly non-catalytic, but possessing many features common to catalytic cracking plants), and the Catarole process in England. In addition, a substantial amount of fundamental information on fluidization, heat and mass transfer, and applied reaction kinetics was introduced to permit better understanding of observed operating phenomena and to furnish a sounder basis for the design of future units.

An estimate by Ray[1] gives an idea of the tremendous proportions that catalytic cracking has assumed. He gives a figure for major catalyst replacements in the year 1948 as 38,000 tons of silica-base catalyst with a value of $10,000,000. In addition, a figure of 1800 tons of alumina-base hydroforming catalyst is presented, representing a value of $3,200,000.

Heinemann has presented a review[2] of the manifold uses of catalysts in all of petroleum refining, including their use in catalytic cracking.

Sachanen[3] points out that there was a single 2000 BPD unit in operation on a catalytic cracking process in 1936 and that capacity has increased to about 1,200,000 BPD of catalytic capacity at the present time.

An indication that catalytic cracking construction is by no means at a standstill is given by a survey of units on the books at the present time. As of December 1948[4], 24 catalytic cracking units were projected or under construction in the U. S., Iran, Canada, and Venezuela. In addition, four units were due for revision due to process improvements.

A recent detailed comparison of actual refinery operating costs of Houdry, Fluid, and Thermofor processes, based on experience in the Sinclair Refining Co. has been presented by Kimball and Scott[5]. The overall cost of thermal cracking was shown to be less than for any of the three catalytic processes. Operating and maintenance labor, as well as operating supplies, were much lower for thermal cracking, but utilities costs are of the same order as those for the catalytic processes.

Of the catalytic processes, the Houdry process required the most operating labor but the least maintenance labor. The Fluid process showed the median catalyst consumption rate (2400 lb./day for a 10,000 BPD unit) of catalyst at 15c per lb. Thermofor catalyst replacement was greater in amount (4000 lb./day for a 10,000 BPD unit), but the relatively inexpensive catalyst (5c per lb.) resulted in a lower total cost. The static-bed Houdry unit showed a low loss of course (436 lb./day for a 10,000 BPD plant), but the unit cost of catalyst is highest (22c per lb.) of those used in the three catalytic processes being compared.

Chemistry

Advances in chemistry as related to catalytic cracking may be divided among the following broad headings:

Fundamental hydrocarbon reactions
New catalyst compositions
Measurement of catalyst activities
Physico-chemical measurements of surface area, particle size, etc.

Much remains to be learned about the fundamental mechanisms of catalytic hydrocarbon reactions. Deuterohydrocarbons, containing deuterium or "heavy hydrogen" are useful in such studies[6]. The heavy hydrogen atoms "tag" the course of the hydrogen in a given feed component during its path to a particular end product. The use of radio-isotopes from the Oak Ridge Atomic Energy Operations, particularly radiocarbon, C_{14}, is currently being undertaken[7] by the major petroleum research organizations.

As part of an Annual Unit Process Symposium, Haensel and Sterba[8] have presented a review of hydrocarbon pyrolysis. It includes both thermal and catalytic cracking, with emphasis on chemical concepts.

New techniques, such as infra-red gas analysis, have been applied to the continuous determination of the course of carbon burning in plant regenerators.[9]

Catalyst compositions which are the subjects of current study for use in catalytic cracking include:

1. Aluminosilicate catalysts—the good old standbys—which are the subject of continuing research on optimum methods of manufacture[10].

2. Silica-magnesia mixtures[11]. Increased gasoline yields (up to 25% over silica-alumina catalysts), better activity maintenance, and lower yields of gas are claimed. Lower product volatility and a 2-3% decrease in octane number accompany the advantages however.

3. Silica-alumina catalysts containing small percentages of copper, manganese, or cobalt oxides[12]. Such additions catalyze the oxidation of CO to CO_2 in a fluid bed and prevent afterburning.

4. Alumina cracking catalysts containing magnesia, chromia, zinc fluoride, magnesium fluoride, boric acid, ammonium fluoborate, and fluosilicic acid[13].

5. Hydrated magnesium silicate-calcium silicate mixtures[14]. Such mixtures are stated to produce gasolines very rich in olefins.

6. Alumina-base hydroforming catalysts containing silica[15]. The addition of 1-15 wt. per cent of silica greatly improves heat stability and thus lengthens catalyst life.

7. Beryllium phosphate[16]. Low gas and coke production are claimed for such catalysts.

8. Cerium phosphate[17].

9. Hydrogen fluoride, promoted by boron trifluoride, in a liquid cracking catalyst composition[18].

10. Admixtures of explosive nitro compounds[19]. A process in which 0.25-3.0 mol% of an explosive such as TNT is added to the hydrocarbon is not strictly catalytic of course. These additive substances are stated

to act as promoters to achieve thermal conversion under milder conditions, or to obtain higher yields.

One aspect of the chemical approach to catalytic cracking problems which has been particularly active in 1948 is that of catalyst activity testing. A symposium on test methods for the evaluation of cracking catalysts was held under the sponsorship of the Refining Division of the American Petroleum Institute in November, 1947, and the papers were published in 1948.

There are two basic classifications of activity test methods. One variety involves surface area measurement as an indirect measure of catalyst activity. The other type employs small-scale laboratory cracking units wherein catalyst activity is determined directly. The surface area measurements are performed rapidly and reproducibly by adsorption of potassium hydroxide, aromatic hydrocarbons, or nitrogen, in various methods. The tests in laboratory cracking units are more representative of actual plant operation, with respect to loss of activity due to coking or contamination, the action of steam, exposure to high temperatures, etc.

The methods of direct catalyst activity measurement in use today are as follows[20]:

1. The U.O.P. Activity Test
2. The Houdry Catalytic Activity Index
3. The Kellogg Fluidized Fixed Bed Activity Test
4. The Jersey D+L Activity Test

The main physical property measurements performed in the catalyst testing laboratory are the determination of density in pounds per cubic foot and the determination of particle size by the Roller method or other methods of analysis.

Kinetics

Applied reaction kinetics forms the transition ground between the work of the physical chemist and that of the chemical process design engineer. Industrial interest in reactor design from the fundamental principles of reaction kinetics has increased greatly in recent years. The published works of Professors Hougon and Watson of the University of Wisconsin have been outstanding in this respect. ("Principles of Reactor Design", published by PETROLEUM PROCESSING in 1946 was among the first publications on this subject to find wide circulation in the petroleum industry.)

The Russians have recently published work on the kinetics of catalytic cracking[21][22].

Mass transfer in fixed and fluidized beds has been studied by Resnick and White[23] and correlations presented which should be useful in reactor design. Kettenring and Smith[24] have also reported on mass transfer in fluidized systems. Hall and Smith have presented[25] a paper on the design of gas-solid catalytic reactors.

The problem of scaling-up catalytic reactors from semi-pilot units to commercial units assumes particular importance in the petroleum industry, where reactor sizes (and correspondingly—costs) greatly exceed those commonly employed in the chemical industry. Bosworth[26] has presented information on this very important subject.

Perhaps equally important with rate studies of the cracking reaction, are rate studies of coke combustion in catalyst regeneration. Dart, Savage, and Kirkbride[27] have reported data on carbon burning rates from pelleted clay catalyst in a moving-bed process. They reported a constant value of activation energy of 26,000 calories per gram mol over a temperature range from 850 to 1300° F.

Sachanen, in the second edition of his comprehensive work, "Conversion of Petroleum" (published in 1948) cites an average value of 20,000 calories for the activation energy in catalytic cracking, as compared to a value of 58,000 calories for non-catalytic cracking[3]. These values explain the relatively unimportant role of temperature in catalytic cracking, as compared to its dominant role in thermal cracking. The catalyst has cut down to almost one-third of its size the energy peak which the feed components must pass over en route to product formation.

Thermodynamics

The heats of cracking and regeneration are important design considerations. Dart and Oblad[28] of the Houdry Laboratories have reported on precise determinations of these heat quantities. They obtained values of 57 B.t.u./lb. of oil feed at 35% conversion and 222 B.t.u./lb. of oil feed at 80% conversion in the cracking of gas oils at 850° F. The heat of combustion of the carbonaceous deposit was found to be 14,250 B.t.u./lb. and did not vary with varying amounts of deposit on the catalyst.

Sachanen[3] has calculated the thermal effect in catalytic cracking and has found it to be from 400 to 1000 B.t.u./lb. of gasoline and gas produced, a value close to that for thermal cracking.

Fluid Mechanics

Under the heading of fluid mechanics of catalytic cracking come the following:

Pneumatic conveying—the transport of solids in gases
Fundamental behavior in fluidization
Fluid flow of gases through packed beds
The flow of granular solids through conduits

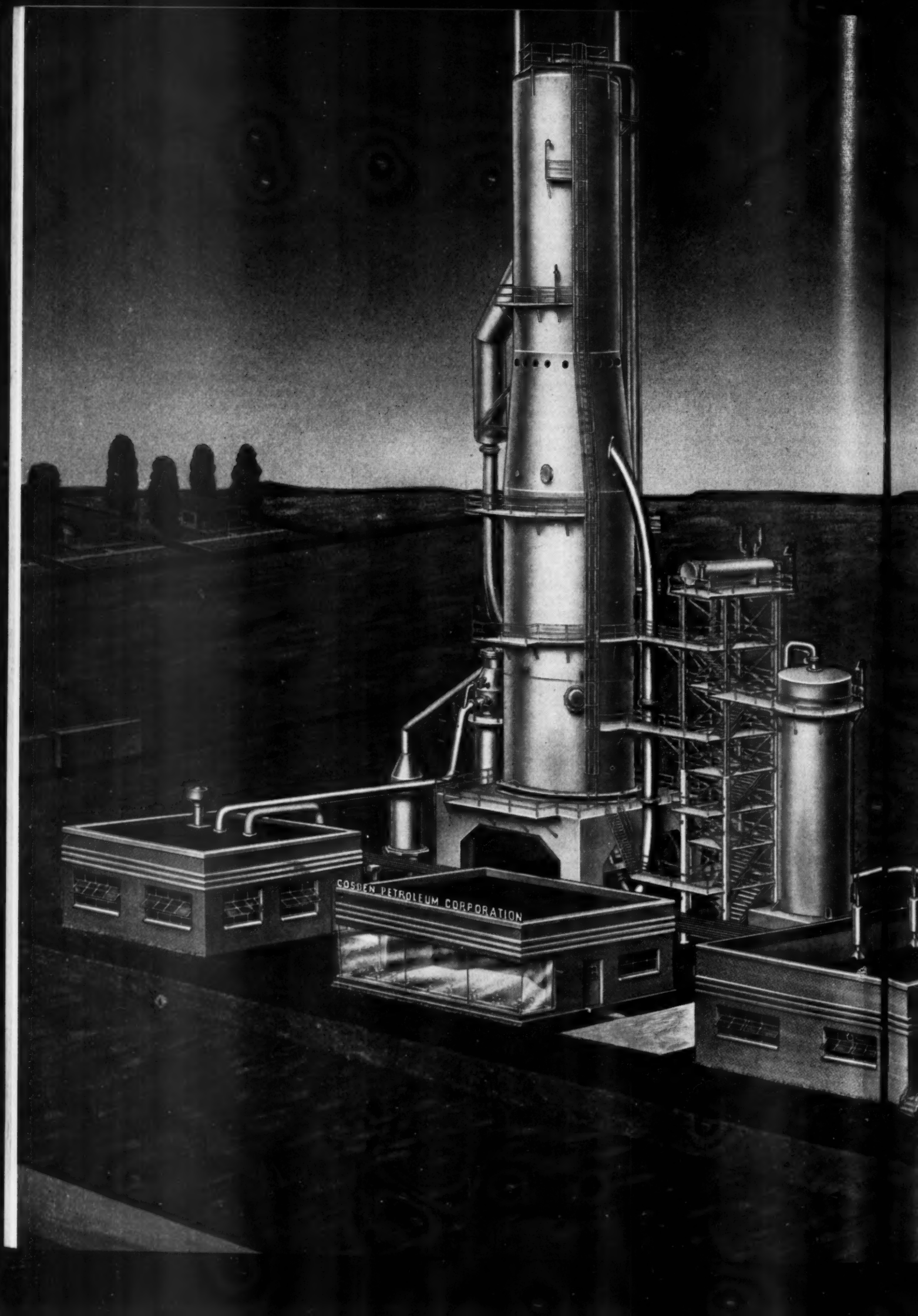
Quantitative data on the conveying of granular solids in gas streams were conspicuous by their absence prior to the advent of the fluid catalyst process for petroleum cracking. Grain, wood chips, and sand have been transported pneumatically in conduits for years without the benefit of any fundamental engineering data. Process design for optimum operation and maximum economy in fluid catalytic cracking have, however, made the development of such data imperative. Recent work at the University of Michigan[29] has provided a start in this direction.

The phenomena of fluidization itself has been the recipient of intense study in this past year. Early in the year, Wilhelm and Kwauk published a paper[30] in which various dimensionless groups were formulated to assist in correlation of data on fluidization. Later in the year, Leva, Grum-

Postwar TCC and Houdriflow Units

Company	Location	Charge Capacity
TCC Process		
Standard Oil Co. of California	Richmond, Cal.	14,000
		11,000
Tide Water Associated	Bayonne, N. J.	10,000
Leonard Refineries, Inc.	Alma, Mich.	3,000
Lion Oil Co.	El Dorado, Ark.	5,400
Continental Oil Co.	Denver, Col.	6,750
Socony-Vacuum Oil Co., Inc.	Casper, Wyo.	6,900*
Houdriflow Process		
Petco Corp.	Blue Island, Ill.	5,000*
Sun Oil	Toledo, O. (6 units)	42,000*
Tide Water Associated	Drumright, Okla.	6,750*

*Under construction.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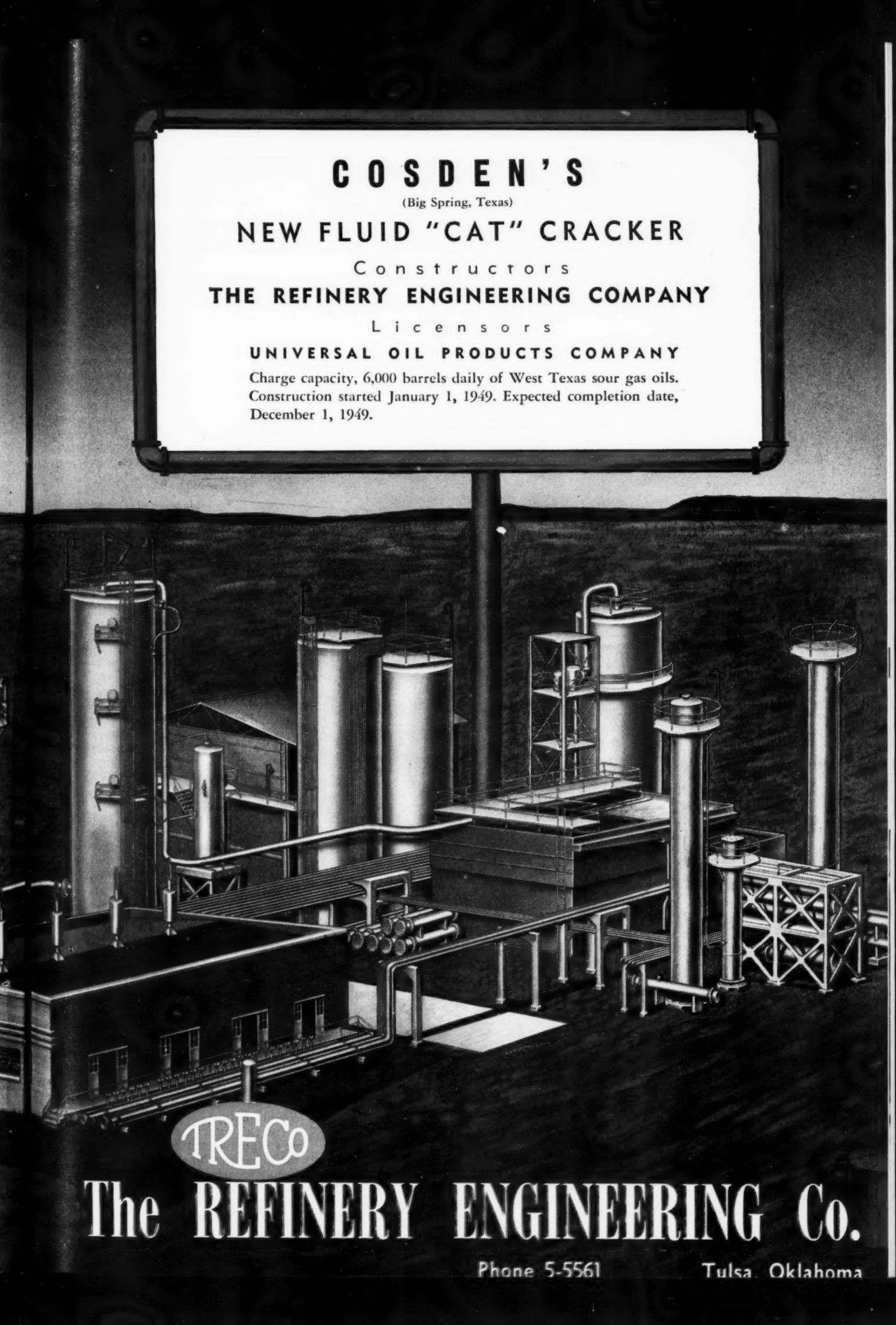
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mer, Weintraub, Pollchik, and Storch of the Bureau of Mines published a series of three papers on fluidization[31][32][33]. As the year ended, a symposium at Boston under the auspices of the Division of Industrial and Engineering Chemistry of the American Chemical Society offered by far the most comprehensive survey of the field to date. A program of 21 papers on all phases of the fluo-solids technique was presented[34] with emphasis on the fundamentals.

The problem of fluid flow through beds of catalyst pellets in fixed-bed or moving-bed reactors is the subject of continuing research. Bernard and Wilhelm have reported[35] on turbulent diffusion in fluids flowing through packed solids. Boucher, in an annual review article on fluid dynamics[36], gives a comprehensive summary of literature references pertaining to the flow of fluids through beds of solids.

The flow of solids alone, particularly pelleted Thermofor catalyst, through valves, orifices, etc. presents a new problem in fluid dynamics. Recent articles in this field are also reviewed by Boucher[36].

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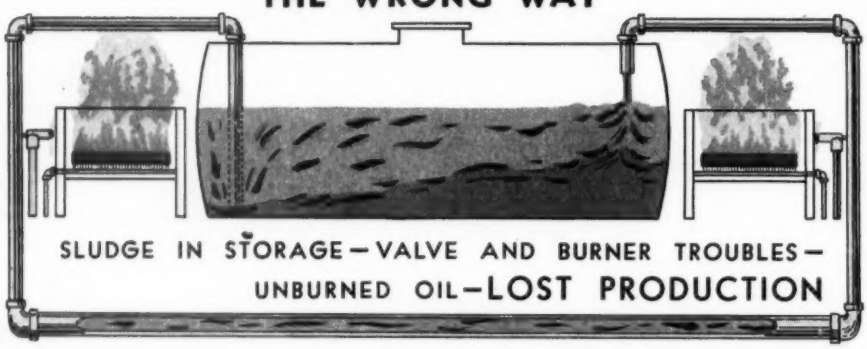

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UNBURNED OIL—LOST PRODUCTION

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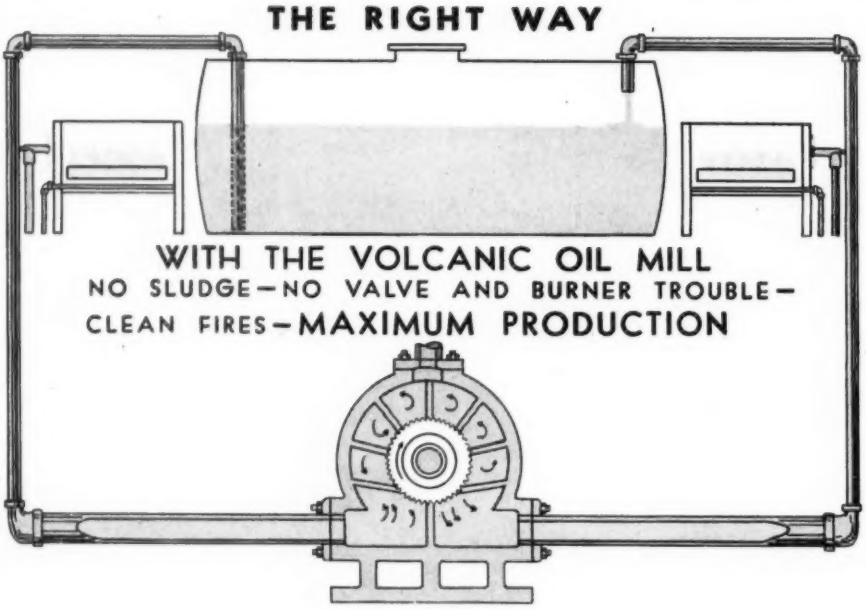

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Commercial Processes

Process development in catalytic cracking in 1948 centered in the moving-bed (transported pellets and fluidized solids) processes as opposed to the static-bed processes.

The Thermofor Catalytic Cracking (TCC) process produced two interesting offspring in 1948. The first of these was the Thermofor Pyrolytic Cracking (TPC) Process which, although non-catalytic, employs so many mechanical features in common with catalytic units that its inclusion here seems pertinent. The second of these was the Houdriflow process, a modified TCC process employing a gas lift for catalyst transportation, replacing bucket elevators.

The TCC Process

Two of the highlights of the year, as regards the Thermofor process, involved the smaller "postwar" units designed for the small refiner.

The 3000 BPD unit at the Alma, Mich., refinery of Leonard Refineries, Inc. was the first of these postwar units to be constructed and it went on stream in March 1947. After an initial run of 222 days, a turnaround was taken on the unit[37]. Since it had operated on stocks containing 0.9% sulfur, considerable interest was evinced in the possible appearance of the equipment upon dismantling. However, severe corrosion was encountered only in the heater transfer lines and in the tar separator bottoms lines. These carbon steel lines were replaced with 4-6% chrome alloy lines. The carbon steel reactor showed no loss of metal from shell or internal elements. A slight amount of erosion was found to have taken effect on the kiln wall insulation. All in all, it was believed that maintenance and repair labor on the catalytic unit will be less than that expended on a thermal unit, based on experience in this turnaround.

A second small TCC unit whose performance on sour gas oils has recently been reported is that of the Lion Oil Co. at El Dorado, Arkansas[38]. As in the Leonard unit, alloy protection was provided only at critical locations in the original design. However, after seven months of operation with an on-stream efficiency of 97%, a turnaround was taken in April 1948. A total turnaround time of only seven days was required and the equipment was found in exellent condition.

On this unit, 4-6% chrome tubing was employed initially in heater and tar separator lines. The original internal construction of the reactor was 18-8 stainless steel in this unit. Some typical operating figures on the Lion unit[38] bear out the desul-

furizing action of catalytic cracking on sour stocks; 55% of the total sulfur in the feed appeared in gas and coke, 42% in the cycle stock, and only 3% in the catalytic gasoline.

Laboratory development work on TCC cracking has gone on in several laboratories. Socony-Vacuum researchers have reported[39] on the constructional details of a 2 BPD TCC pilot plant in the Paulsboro, N. J. laboratory. Shabaker of the Houdry Process Corp. has reported [40] on the steam aging of TCC pelleted catalyst, based on controlled laboratory studies.

A variety of patents have been issued in 1948 on equipment details for moving-bed catalytic cracking units. A gas seal at the top of the kiln is the subject of one such patent[41]. An elutriator for the removal of fines by dropping catalyst through a transverse purge stream is the subject of another patent[42]. A disengager for seal vapor at the bottom of the reactor[43] claims improved accuracy of catalyst flow control by maintenance of a full flow of catalyst to the valve at all times.

Space velocity in a TCC reactor may be controlled, according to a recent patent[44], by altering the height of the catalyst bed by means of telescoping catalyst downspouts, controllable from outside the reactor.

The TPC Process

Interest in chemical raw materials from petroleum, such as ethylene, acetylene, and aromatic hydrocarbons, has spurred on the development of the Thermofor Pyrolytic Cracking process. The "pebble heater" which had previously been covered in various patents[45][46] was the fore-runner of the TPC process, which was first announced in 1948[47]. In this process, non-catalytic granules similar in shape to catalyst pellets or beads are heated by direct fire through combustion of fuel gas within the pebble bed, which is mounted directly above the reactor.

The hot pebbles flow by gravity into the reactor, where they lose heat in the endothermic cracking reaction. They are depressurized and returned to the regenerator-heater by a bucket elevator. Pebble preheat temperatures of the order of 1500° F. are typical in the TPC process with pebble-to-hydrocarbon ratios by wt. running from 10 to 20. Ultimate ethylene yields of the order of 60% are reported in the cracking of C_2-C_3 gas mixtures by the TPC process.

The Houdriflow Process

A joint development of the Houdry Process Corp. and the Sun Oil Co., the Houdriflow process was announced late in 1948. Its introduction was somewhat unique in that an engineering paper dealing with the economics of the new process was presented[48] almost simultaneously with its first public announcement and before construction of any commercial units.

The use of a flue gas lift in place of a catalyst elevator is the fundamental design difference between the new process and the older TCC Process[49]. To make the gas lift possible, the kiln has been redesigned and located below the reactor where it is operated under 6-10 psi. gage pressure to provide gas for the catalyst lift. Catalyst drops from the kiln to the pickup point of the pneumatic conveying system, whence it is carried to the top of the unit, separated from the flue gas, and dropped into the reactor, from which it flows by gravity into the kiln again.

Decreased construction costs through "packaged unit" assembly and simplified kiln construction are claimed, as well as reduced operating costs due to lower maintenance. The simplified kiln construction is a direct outcome of the removal by the gas lift of limitations previously placed on catalyst circulation rate by bucket elevators. Catalyst-to-oil ratios of 4-8 are projected for Houdriflow units, where ratios of 2-3 had been common in TCC practice. Increased catalyst flow of course means increased permissible heat pickup by the catalyst, and a reduction in the number of burning zones.

Eight units, aggregating almost 54,000 BPD of Houdriflow capacity are on order.

Another type of catalyst lift, eliminating the catalyst elevator, employs molten lead or liquid mercury to provide a combined gas seal and catalyst lift in a process patented by the Lummus Co.[50].

The Fluid Process

In 1948, the Fluid process had its sixth birthday in commercial operation[51]. During that period, many changes have been made. Recycling has been employed to an increasing degree to improve yields. Capacities of units have been increased by special feed preparation (propane decarbonization e.g.) and by the use of preheat furnaces.

Improved fundamental design "know-how" plus balanced pressure operation have reduced the height and, correspondingly, the structural cost compared to some of the earlier "skyscraper" units. One design, which has not been applied on a commercial scale, is that in which both reactor and regenerator are located at ground level and star feeders are employed for sealing one vessel from the other, eliminating standpipes, etc.[52].

New catalysts, such as the silica-magnesia catalyst[11] have been developed and are in commercial use. Catalyst strippers at the base of the reactor have been the subject of much variation, evolution, and improvement[53]. The use of a separate stripper, located either inside or outside of the reactor, has greatly reduced the loss of liquid hydrocarbons from the reactor to the regenerator.

The slurry settler has been incorporated into the base of the fractionator in recent units. A separate classifier was formerly employed in this service.

Dust removal from exit gases has been streamlined. Electrostatic precipitators are now mounted in cylindrical, rather than box-shaped shells. This reduces potential points of leakage and makes for stronger, more nearly self-supporting construction and makes possible operation at higher pressures than were possible with a flat-sided vessel. The cost is approximately 30% lower than for an old-type square precipitator.

Improvements in refractories have made possible decreased regenerator maintenance.

Just as fume elimination and stream pollution are common problems in the chemical industry, so noise abatement has become a problem in Fluid units. Regenerator exhaust noises have had an adverse effect on employee morale in refinery areas[54]. Double slide valves, with the opening always centrally located in the pipe, have been used to cut down sound-producing eddy currents[51]. Perforated orifice plates have been used to cut down sound intensity and special fibrous silica liners have been used to absorb sound in the stacks[54].

Just as considerable interest has been evinced in Thermofor units for the small refiner, as described in the preceding sections of this paper, so has much interest been shown in small Fluid units. The 4500 BPD Fluid unit at the Casper, Wyo., refinery of The Texas Co. has been quite thoroughly described in the recent literature[55][56][57]. This was the first unit to employ an exterior stripper for spent catalyst leaving the reactor, insuring positive catalyst withdrawal and better controlled stripping. It was also the first unit to employ "balanced pressure" design, whereby reactor and regenerator are placed side by side at the same level, permitting a much simpler and lower steel support structure. An illustrated outline of the startup procedure for this unit at Casper has been published[57].

Maintenance of Fluid cracking units is a subject of vital and continuing interest. The repair of leaks in lines and vessels of Fluid units while in operation was the subject of one recent paper[58].

The tremendous size of much of the equipment in these units makes the solutions of construction problems

an art in themselves. Be it the installation of a Multiclone separator[59] or the construction of an entire unit[60], it is a huge task in any case.

The fundamentals of heat transfer in fluid catalyst processes are the subject of much current research. Investigators at the Bureau of Mines have reported[61] on heat transfer through fluidized beds. The Texas Co. recently established a fellowship[62] to further study heat transfer in fluid catalytic processes. Aside from the more complex applications of such data in process design work, handy everyday calculations may be based on heat balances, such as determination of catalyst flow[63].

Many pilot plants are operating to guide the huge parent units on the road to trouble-free, economic operations[64][65][66][67] as well as for determination of basic engineering data, and for catalyst testing.

Although we are concerned primarily with the Fluid Catalyst process as applied in catalytic cracking, fluidization is finding so many diverse applications in non-cracking and even non-catalytic processes that we are forced to strike up some acquaintance with these processes so that we may adapt process or equipment innovations from these operations to our own benefit in catalytic petroleum cracking.

The production of synthetic liquid fuels by shale retorting, by the so-called "American Fischer-Tropsch" process, or by coal gasification, are foremost in the allied applications of the fluidized solids technique[68][69][70][71].

Purely chemical applications of fluidization have been few, but many potential applications exist[72] ranging from calcination of limestone to the distillation of hardwood[73]. Petroleum refiners should be aware of developments in fluidized processing in chemicals manufacture.

The Catarole Process

The Catarole process, which was announced in England in 1947[74] has progressed to the point where plant construction on an initial 1500 BPD unit was to have been completed by the end of 1948[75]. Additional units are planned for 1949.

Fuel Gas By Catalytic Cracking

A process developed by the Surface Combustion Corp. and applied by the Long Island Lighting Co. marked the advent of catalytic cracking into gas manufacture by a utility company[76]. A mixture of hydrocarbon vapor, steam, and air are fed into direct-fired tubes containing the catalyst—to give a mixture of carbon monoxide and hydrogen which may be mixed with more hydrocarbon vapor to give an exactly controlled composition. The unit is stated to be unique for its compactness and flexibility of operation. The catalytic process is an ideal solution to the "peak-load" problem in utility operation[77].

Suspensoid Process.

A Suspensoid process pilot plant has been described in detail[78] by Flanagan.

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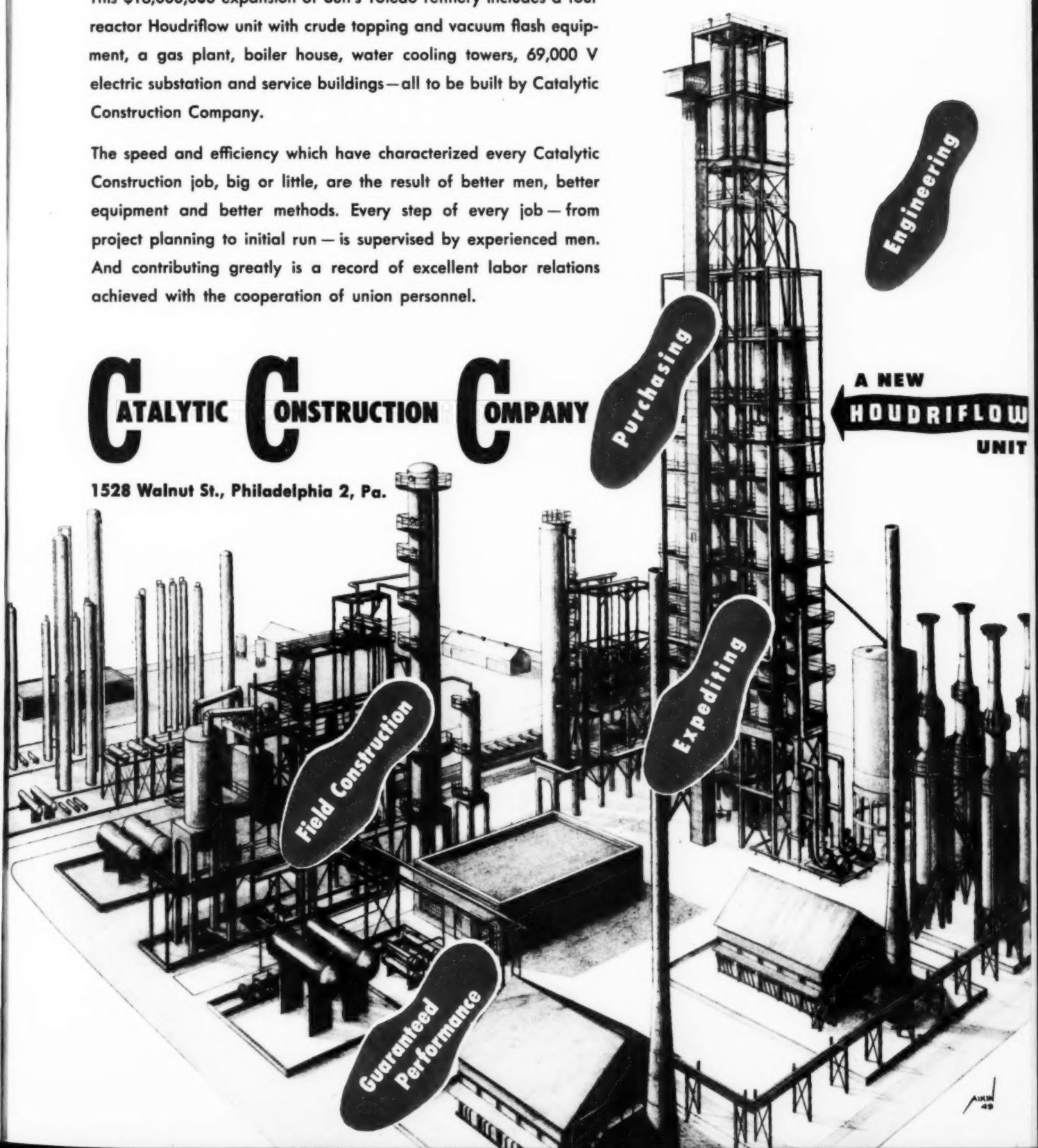

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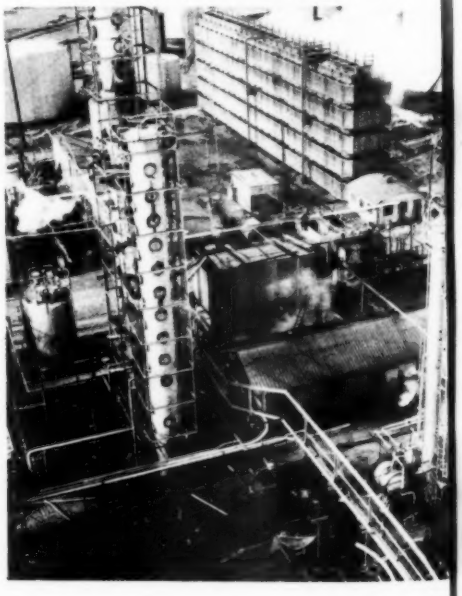

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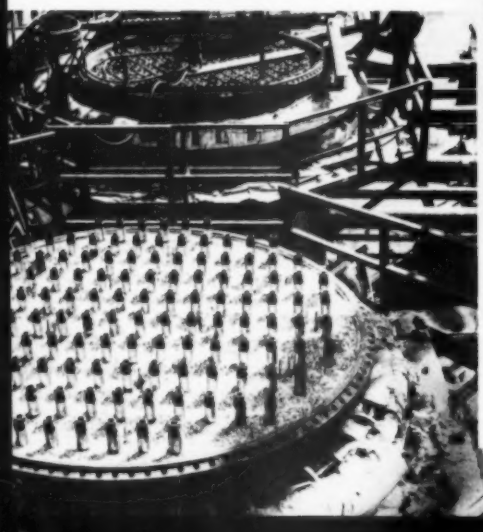
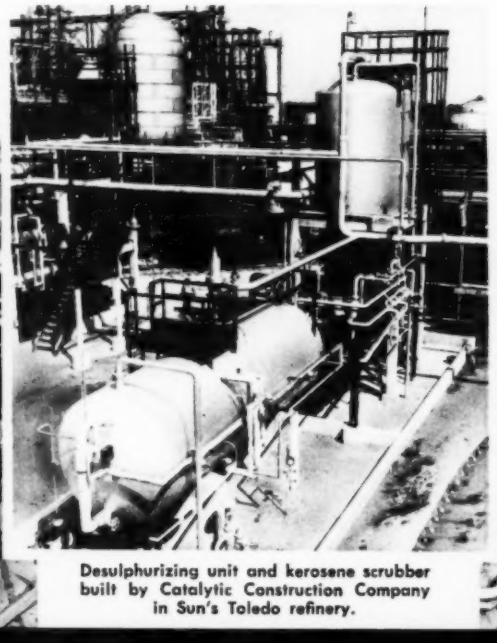
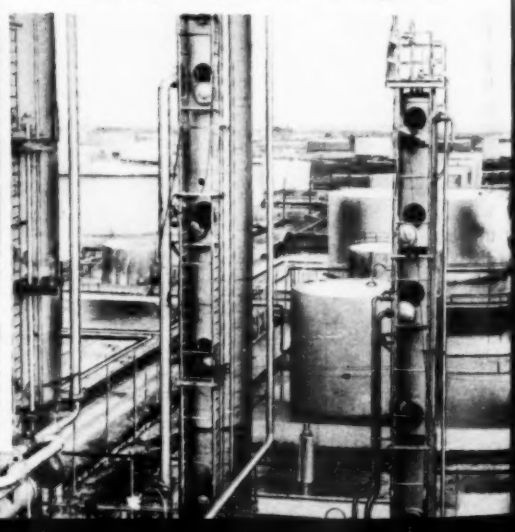




Desulphurizing unit and kerosene scrubber built by Catalytic Construction Company in Sun's Toledo refinery.

Catalytic did a complete refinery overhaul for Petrol Refineries Inc. at Texas City, Texas.



Field Testing For TEL in Air By New Ten Minute Method

Typical inorganic sampling techniques have not been successful in the determination of tetraethyl lead vapor in air. Ethyl Corp. technologists, recognizing the need for a rapid, accurate, field method in maintaining close control of health in all industries handling their product, have developed a new procedure and field kit which is now used by the company. It has largely supplanted conventional lengthy laboratory methods. The analysis is based essentially upon an adaptation of the high pH dithizone method developed originally by Ethyl.

A RAPID MICROMETHOD for determining tetraethyl lead in air, developed by Ethyl Corp. technologists, is said to require about 10 minutes and is accurate to better than one microgram of lead per cubic foot of air. Analysis can be performed in the field with a small, portable, sampling and reagents kit.

Essentially a color comparison procedure, the method is based on the reaction of tetraethyl lead with iodine to form a series of ethyllead iodides, which in turn form colored complexes with dithizone.

Tetraethyl lead vapor is not sampled successfully by typical inorganic lead-in-air sampling methods, such as electrostatic precipitator, impingers, or filter paper devices, the chemists explain. In addition, earlier analytical methods have been long and tedious, requiring very large air samples and day-long laboratory procedures.

Rapid analyses are essential for industrial health control in the lead-handling industries, and particularly in petroleum processing, where lead is in the relatively volatile form of TEL fluid. The new Ethyl procedure and apparatus was developed primarily as safety equipment. Generally a sample may be collected and analyzed in less than 10 minutes without a constant error. In the range corresponding to human tolerance limits (0 to 4 micrograms of lead per cu. ft. of air) the precision of the Ethyl method is ±0.5 micrograms; in the higher range up to 20 micrograms the precision is ±10% of the amount present.

The new procedure, applicable also to inorganic lead samples and to determination of lead in liquids such as water, gasoline, and oils, is based upon an adaptation of the high pH dithizone method previously developed by Ethyl.[1] This dithizone method is essentially a single-color method in which repeated extraction with an ammoniacal solution is not necessary to remove the excess dithizone from lead dithizonate. A single extraction contains all the lead dithizonate and an insignificant amount of free dithizone. The pH of extraction is approximately 11.0.

Reagents

Iodine Solution (1.0 *N*): Dissolve 250 gms. of potassium iodide in 750 ml. of water in a separatory funnel. Delead this solution as follows:

First add thymol blue indicator and make alkaline with ammonium hydroxide. Shake with 25-ml. portions of dithizone solution until the last portion added retains its original color. Wash the aqueous solution twice with 25 ml. of clear chloroform and filter the aqueous solution through a fluted filter paper (previously wetted with water) to remove the chloroform. Add dilute nitric acid with constant stirring until the solution is neutral to the thymol blue indicator previously added. In this solution dissolve 125 gms. of resublimed iodine and dilute to 1 liter with lead-free water. Pipet 10-ml. portions into 4-dram screw-cap bottles, close with paraffin-gasketed caps, and seal with gel caps.

The iodine solution is stable indefinitely. However, it solidifies at approximately 24° C.; therefore, to collect samples below this temperature, a small amount of alcohol may be added to lower the freezing point.

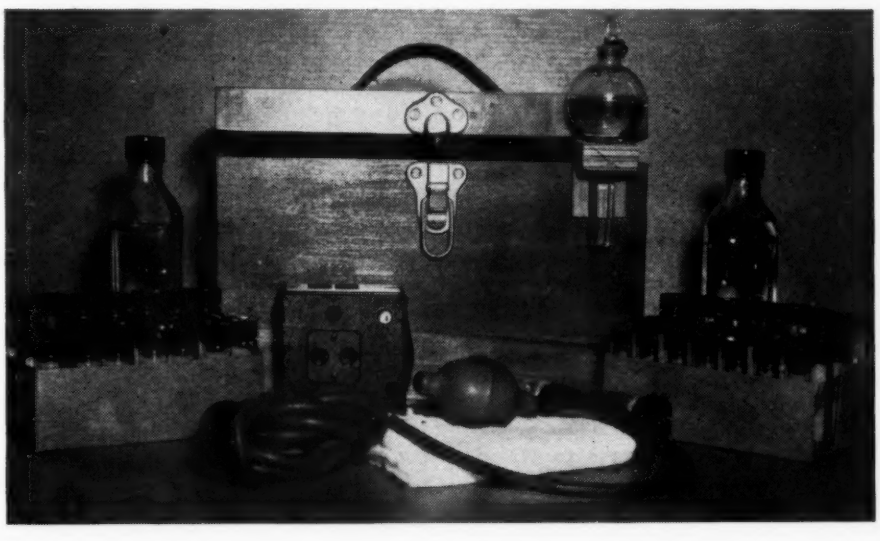
Solution A: Dissolve 10 gms. of potassium cyanide, 100 gms. of sodium sulfite (anhyd.) and 20 gms. of ammonium citrate in 550 ml. of distilled water. Delead this solution as described above, but do not acidify after deleading. Dilute the deleaded solution with 1950 ml. of lead-free ammonium hydroxide (sp. gr. 0.900). Pipet 30-ml. portions into 8-dram bottles, close, and seal as described for the iodine solution.

Kimble glassware is satisfactory for the storage of Solution A. In a 9-month storage test, a batch of Solution A stored in Kimble glassware showed no appreciable lead blank.

Chloroform: Baker's C.P. chloroform was found satisfactory for use without further treatment. Pipet 10-ml. portions into 4-dram bottles, close with silver-gasketed caps, and seal with gel caps.

Dithizone: Dissolve 40 mg. of dithizone in 20 ml. of chloroform. Pipet 0.20-ml. portions of this solution (from a micro-pipet) into 4-dram screw-cap, brown bottles. Place the bottles in a vacuum dessicator and evaporate the chloroform by reducing the pressure to 15 ml. of Hg. for about 25 minutes. Close with screw caps; no special gasket or gel cap is needed. At time of use the dithizone is redissolved in chloroform to make the dithizone solution referred to.

To ensure the use of a stable dithizone-chloroform solution after several months' standing, it was necessary to



The reagent box contents includes 14 bottles of each of the four solutions, a supply of distilled water, the color comparator, and comparator tube

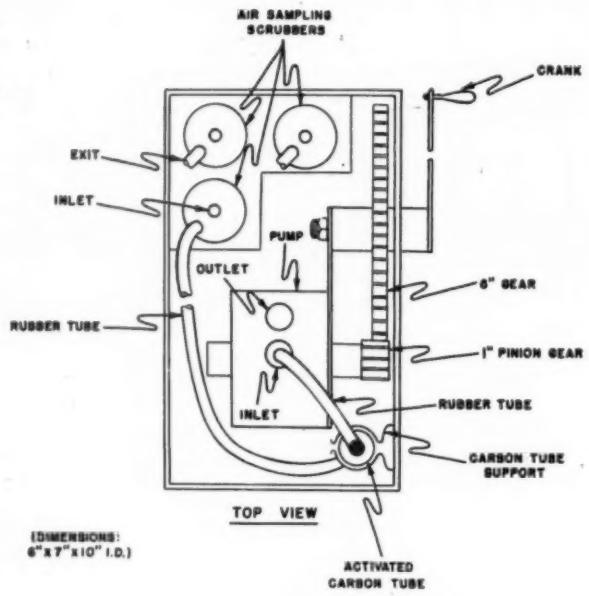


Fig. 1—Above; the sampling unit is contained in a plywood case provided with a convenient carrying strap

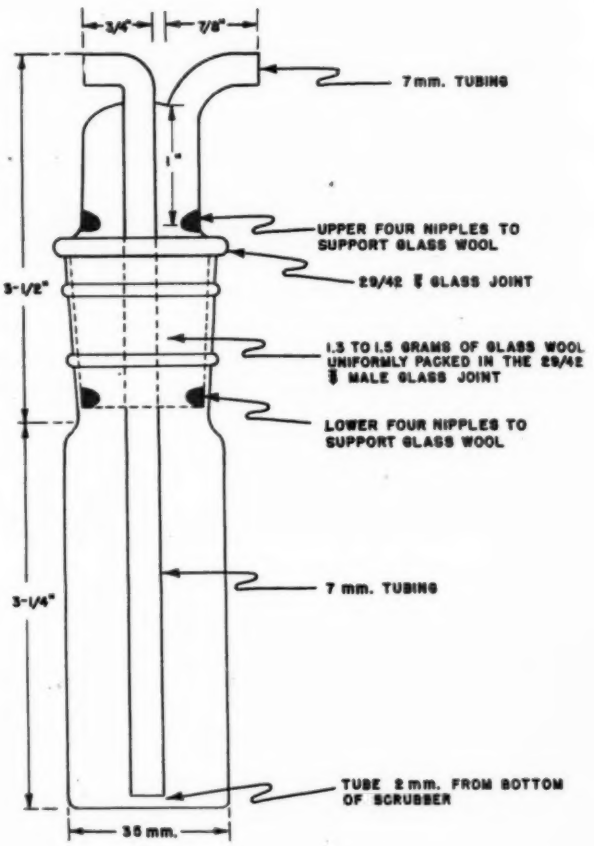

3/4"
7/8"
7mm. TUBING
1"
UPPER FOUR NIPPLES TO SUPPORT GLASS WOOL
3-1/2"
29/42 ♀ GLASS JOINT
1.3 TO 1.5 GRAMS OF GLASS WOOL UNIFORMLY PACKED IN THE 29/42 ♀ MALE GLASS JOINT
LOWER FOUR NIPPLES TO SUPPORT GLASS WOOL
3-1/4"
7 mm. TUBING
TUBE 2 mm. FROM BOTTOM OF SCRUBBER
35 mm.

Fig. 2—Right: three sampling scrubbers made to the dimensions shown are an integral part of the sampling apparatus

dispense the dithizone and chloroform separately. All attempts to preserve a stored mixture proved unsuccessful; storage in separate containers has been found satisfactory after as much as a year, according to the Ethyl chemists.

Apparatus

The field kit consists of two parts; the air-sampling apparatus, and the reagent box. The sampling apparatus, shown in Fig. 1, is housed in a plywood box, measuring overall 6 x 7 x 10 in. Weighing a total of 10 lbs. the box is equipped with a 6-ft. adjustable strap to facilitate carrying. Contents include an air-sampling pump, three air-sampling scrubbers, an activated carbon tube, and a small oil can for the pump.

The pump is basically a No. 26-1½ Leiman pump or its equivalent. A purchased model was adapted by adding a hand crank and gear assembly (6-1 ratio) and by rebuilding the heavy iron side plates and housing with aluminum to reduce weight. As modified, the pump has a capacity of 1.0 cu. ft. of air per 90 crank revolutions. No. 10 SAE oil is used for periodic lubrication.

The pump is calibrated by connecting the vacuum side to a gas meter or a flowmeter and counting the number of revolutions necessary to collect a 4-cu. ft. air sample. If the pump is operated at approximately the same rate at which is calibrated, the sample may be collected with an accuracy of ±2%. Calibration should be checked periodically.

The air-sampling units are modified impinger scrubbers especially developed for this application. Illustrated in Fig. 2, these units can now be purchased from the Ace Glass Co.

Air enters the inlet tube at the left and passes down the long central impinger tube, striking the bottom of the scrubber. It then passes upward through glass wool and out through the tube extending to the right.

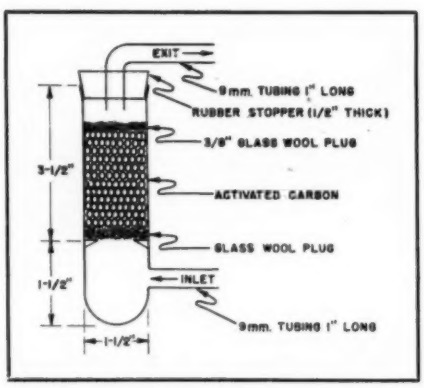


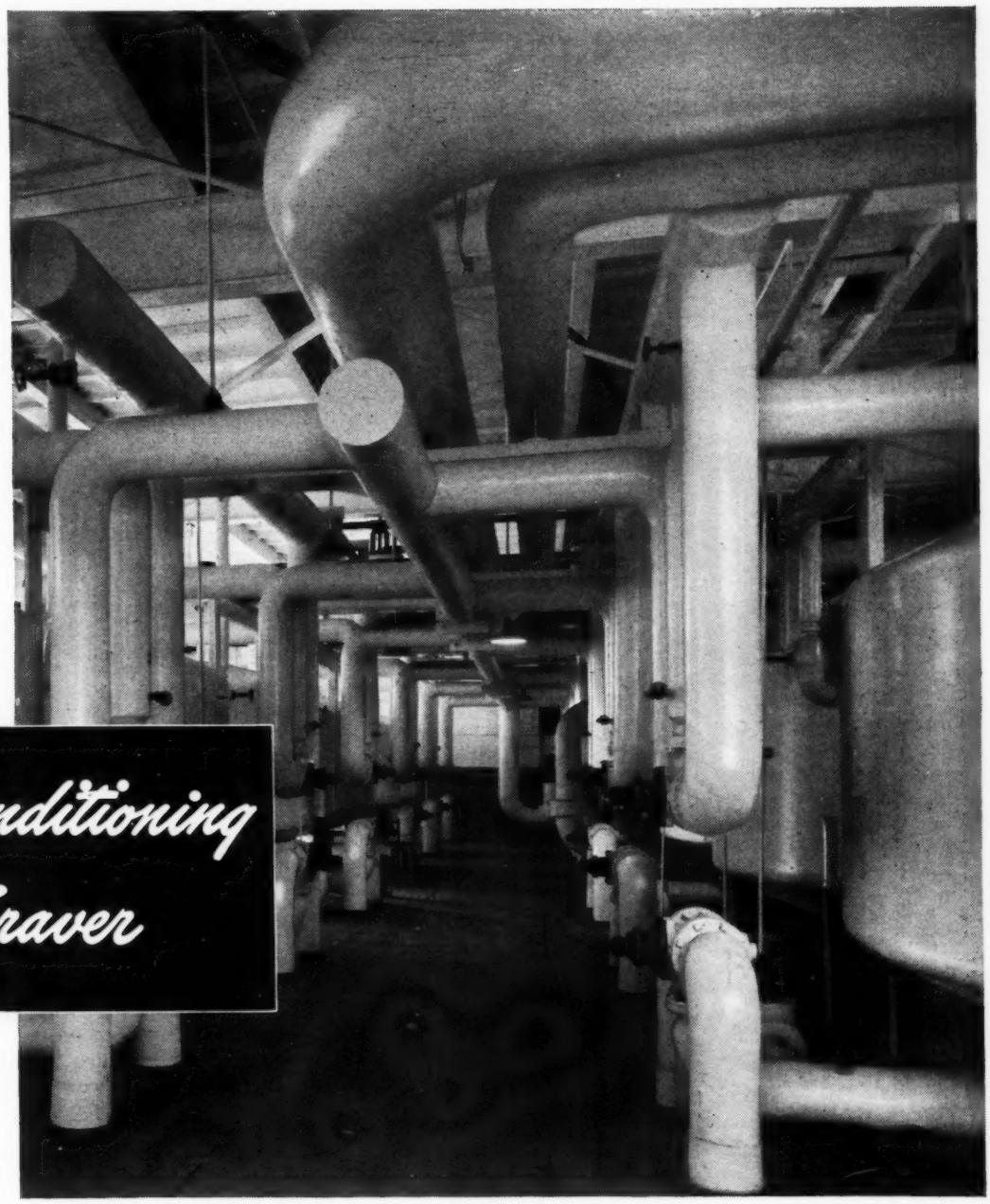
Fig. 3—An activated carbon tube prevents corrosive iodine vapors from damaging the air sampling pump

Glass wool is necessary to assure complete removal of TEL from air. The amount of wool is important; the use of too small a quantity will result in lead losses. At least 1.5 gm. of glass wool must be used for satisfactory lead removal efficiency, it was found in efficiency tests at the rate of 60 cu. ft./hr.

The scrubber is easily and best cleaned by flushing with tap water and rinsing with distilled water. Use of hot acid or alkali rinses during analyses will dissolve some of the glass and give high results.

The activated carbon tube, shown in Fig. 3, is an adsorption unit to remove corrosive iodine vapors from the air stream entering the pump. It contains 20 gms. of 4 x 10 D granular activated carbon, which should be replaced after 50 samples have been collected. The tube also serves as a reservoir for moisture carried over during sampling. The water collecting beneath the carbon should be drained periodically.

The reagent box, shown in the photograph, is made of plywood and measures 6-1/2 x 8 x 12 in. Containing reagents for 14 determina-



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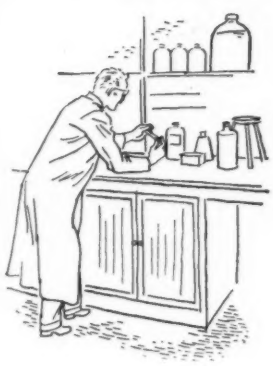

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tions and the accessory equipment needed in the analyses, it weighs 11-1/2 lbs. A leather hand grip is provided. The reagents comprise 14 bottles of each of the four solutions previously described.

Color Comparison

With the cooperation of the Hellige Co., a special lead dithizonate disk, No. 351-D, was prepared for use with the standard Hellige comparator No. 605. The disk is calibrated in micrograms of lead per cu. ft. of air based on a 4-cu. ft. air sample. Disk readings are 1, 2, 3, 4, 6, 8, 10, 15, and 20. Discrimination between the colors in the 0 to 4 microgram range is good enough that units of 0.5 microgram of lead per cu. ft. of air are easily distinguished.

The color comparator tube (Fig. 4) is a specially designed vessel in which the field analyst mixes the reagents, develops the color, and views the density of the lead dithizonate complex directly in the comparator. The tube can now be purchased from the Fischer & Porter Co.

A small rubber bulb attached to a 12-in. piece of rubber tubing is used to force the iodine and wash solutions from the sampling scrubber. It also serves to force rinse water out of the glass wool between uses. Normally, the water will drain from the scrubber by gravity, but the glass wool will remain saturated. The collection of an air sample through such water-saturated wool will cause flooding and possibly lead losses by entrainment. It is not necessary, however, to dry the glass wool completely.

Procedure

Pour the iodine solution (10 ml.) from its screw-cap bottle into an air sampling scrubber and draw a 4-cu. ft. air sample through at the rate of 40 to 60 cu. ft. per hr. Since the kit contains three scrubbers, three samples may be collected and analyzed later.

After collecting the sample, pour Solution A (30 ml.) into the comparator tube. Drain the iodine solution from the scrubber into the comparator tube, and rinse the scrubber with two successive 20-ml. portions of distilled water. Use the small rubber bulb to force the iodine and wash solutions from the scrubber.

Stopper the comparator tube, shake it for 3 seconds to ensure complete reduction of the iodine solution, and add 10 ml. of dithizone solution. (This is prepared on the spot by pouring 10 ml. of chloroform into the bottle containing the dry dithizone, which dissolves on contact.)

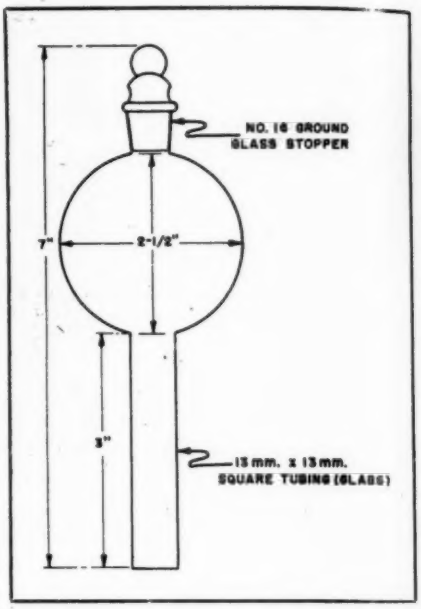

Fig. 4—Actual field analysis of sample occurs in this color comparator tube. Discrimination between colors is such that units of 0.5 micrograms of lead per cu. ft. of air are easily distinguished

Shake the comparator tube vigorously for 30 secs. and observe the color of the dithizone solution—the lower layer. This will be colorless, red, or orange. If the solution is colorless, the sample is lead-free. If it is cherry-red, insert the comparator tube in the Hellige comparator. Match the unknown with a standard and read the number in the upper right-hand corner of the comparator.

If the solution is orange, a low reading will be obtained with the comparator. If the temperature is below 60° F., the orange color probably indicates incomplete tetraethyl lead decomposition. In this case another sample must be collected and heated before analysis. While it is satisfactory to heat to 80° F. for 10 minutes, it may be more convenient to heat above 150° F. for two minutes. After heating, proceed as previously described.

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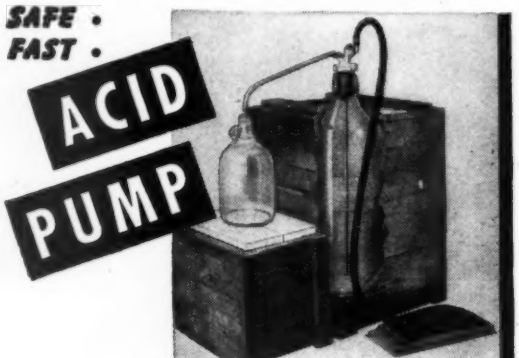
Acknowledgment

The accompanying article is based on the paper "Determination of Lead in Air", by L. J. Snyder, W. R. Barnes and J. V. Tokos, Ethyl Corp., Baton Rouge, La., published in the August, 1948, issue of *Analytical Chemistry*.



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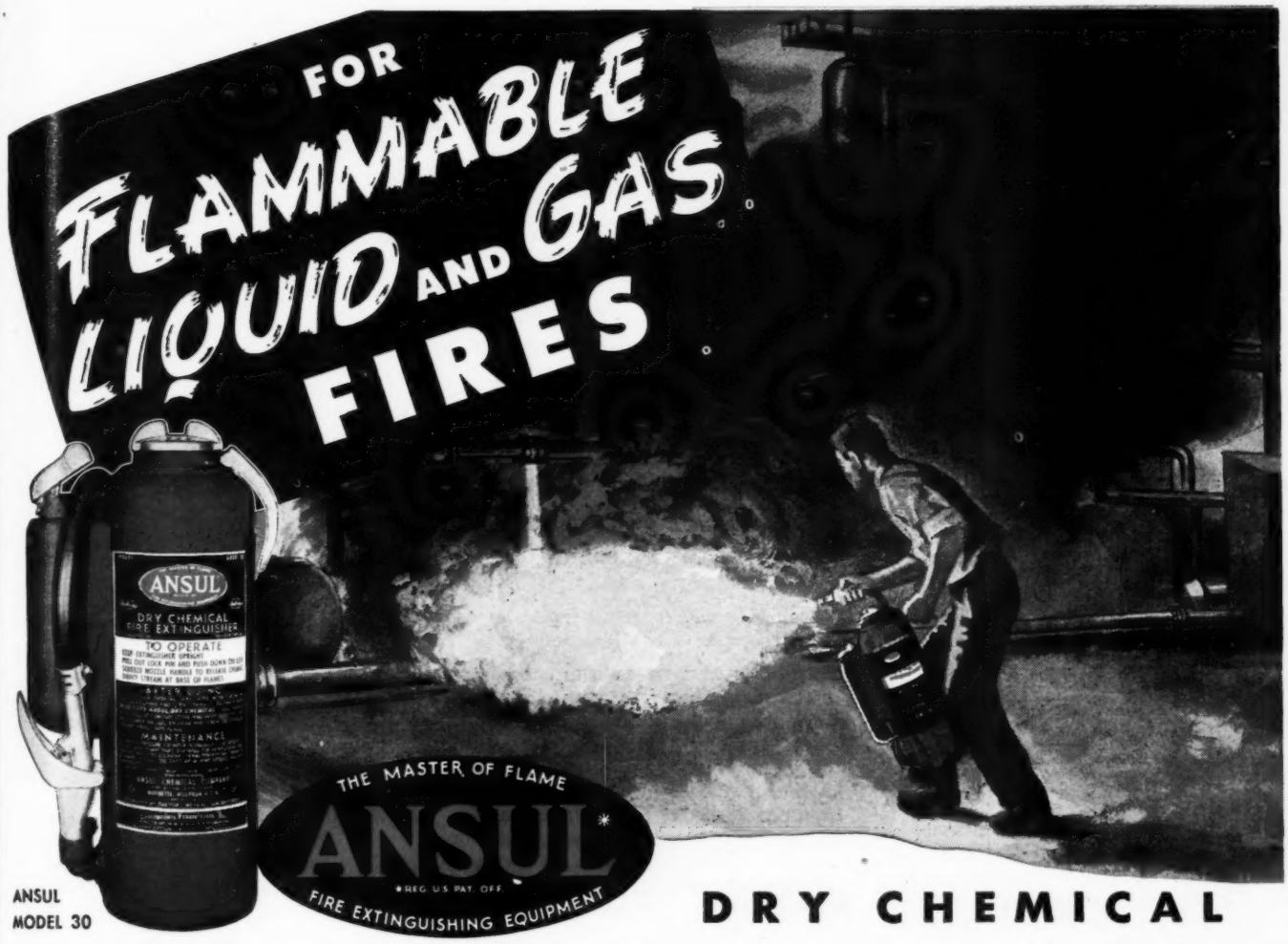

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Evaluating Coastal Type Crudes For Lubricating Oils

BY E. C. DAIGLE and J. B. STRIPLING
Technical Department, Refining Division,
Magnolia Petroleum Co., Beaumont

A method for evaluating coastal type crude oils is presented, which makes possible the estimation of yields and properties of any desired combination of distillate products. The feature of this method is a curve developed from experimental data which correlates the yield of a product with its flash point.*

IN THE LABORATORY evaluation of crude oils for their lubricating oil content it is customary to split the crude by distillation into cuts of the desired viscosities and flash points or other physical properties as established by the individual refineries[1]. Use of such a procedure has the disadvantage that additional evaluations are required to meet changing specifications and market demands. This is particularly true in the case of coastal type crudes where a variety of distillate lubricating oils is produced.

An evaluation which is substantially universal in its application to coastal type crude oils has been developed in the Magnolia Petroleum Co. laboratories. The purpose of the method is to eliminate the necessity for repeatedly evaluating a crude oil for new products, as mentioned above, and to increase the accuracy of such evaluations.

The method consists of a standardized procedure for distilling the crude oil into fractions, combined with a system for interpreting data derived from tests on these fractions.

The distillation is run according to methods already standardized provided the separation obtained is at least equal to that experienced in the plant unit employed in processing such crudes. However, to obtain maximum yields true boiling point analysis would be required. The distillation is divided into two parts, i.e., atmospheric and vacuum. The atmospheric distillation includes all material from start to 500° F. vapor temperature which may be taken in fractions for blending according to the needs of the individual plant. The residuum from the atmospheric distillation is then recharged to a vacuum distilling apparatus and cuts amounting to 5% of the original crude charge are collected. The size of the cuts may be varied to suit individual needs but cuts of 5% of the original charge have been found quite suitable when using a 4-liter original charge. The distillation is carried as far as possible without appreciable cracking. It is desirable to distill under as low a pressure as practical in order to obtain the more viscous fractions which may be included in high viscosity distillate products of present or possible future interest.

Each 5% fraction from the vacuum distillation is tested for gravity, flash point, pour point, viscosity at 100° F., viscosity at 130° F., viscosity at 210° F., and any other physical test which may be employed in controlling the production and blending of coastal lubricating oil distillates. The tests are then plotted against cumulative mid-percent point on graph paper of suitable scale and size and curves drawn for use in determining the yields and physical properties of any desired combination of products. Figs. 1 and 2 are examples of such plots.

Interpretation of Data

In order to calculate the yield of a selected refinery stock a yield is assumed and a "trial product" is located on the viscosity distribution curve having the desired viscosity at its mid-point. The assumed yield is then divided into equal portions for calculating the viscosity, the number of portions chosen being that which will give fraction yields nearest to 5.0%. Since the data are obtained on 5.0% fractions, calculations based on smaller portions will not result in improved accuracy. The viscosity of the blend of the equal portions is then determined stepwise by means of an alignment chart, Fig. 3. This chart is a slight modification of a chart for blending oils of the same base published by O. G. Wilson, Jr., in *National Petroleum News*, May 22, 1929. In the event that the calculated

* Presented before Southwest Regional Meeting, American Chemical Society, Shreveport, La., Dec. 10, 1948.

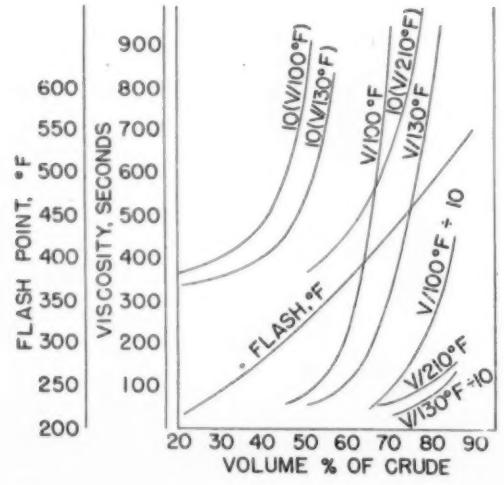
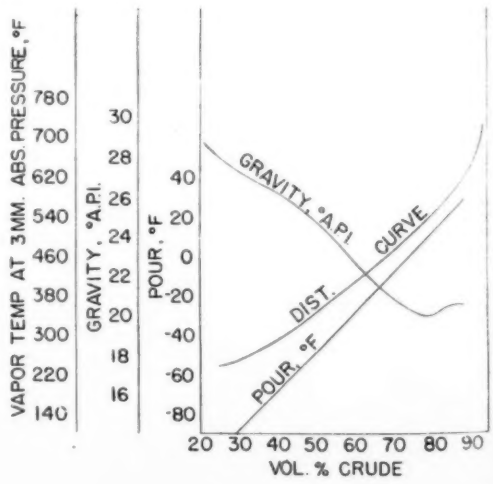


Fig. 1 (left)—Plot of test data

Fig. 2 (right)—Plot of test data



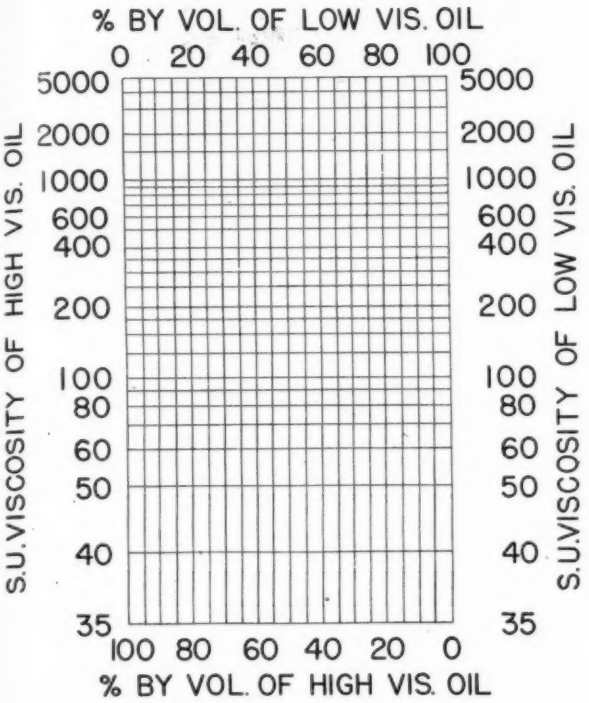


Fig. 3—Viscosity blending chart

viscosity differs from the desired viscosity, the correct position of the "trial product" can be located with one or two additional trials.

By means of the curve shown in Fig. 4 the yield of a product having the desired flash point and the same mid-point as the above "trial product" is determined. This curve was developed experimentally in our laboratories and has been found to be quite accurate for coastal type crude oils having less than 10% off at 400° F. For exceptional crudes containing more gasoline suitable corrections may be made.

By calculating the viscosity of the above product it can be determined how much the mid-point needs to be shifted, if any, and the maximum yield and position of the desired fraction is thus obtained. The other tests such as gravity and pour point are estimated by taking an arithmetic average of these tests on the same portions as those used in determining the viscosity.

The yields and properties of other stocks may be calculated in a similar manner, the flash blending chart of Fig. 5 being used for the blending of non-adjacent cuts. This chart was developed by Louis Hodous of the Canfield Oil Co.

Example

To illustrate this precedure it may be assumed desirable to produce the maximum yield of a stock having a viscosity at 100° F. of 240 to 250 seconds and a minimum flash point of 370° F. from the coastal crude having the test data illustrated in Figures 1 and 2. The following steps would be taken:

1. Locate 250 seconds on the viscosity at 100° F. curve shown in Fig. 1. This falls on the 61.1% point.

2. Assume a yield of stock having this mid-point, 10% in this case.

3. Divide the 10.0% into two 5.0% portions. The mid-fraction of portions 1 and 2 are at 58.6% and 63.6% and represent viscosities at 100° F. and 180 and 350 seconds respectively.

4. Determine the viscosity at 100° F. of a blend of portions 1 and 2, by means of Fig. 3. The result is 248 seconds.

5. Determine the yield of a product having the above midpoint and a 370° F. flash point. From the flash point curve, Fig. 1, it can be determined that the narrow fraction having a 370° F. flash point falls at the 59.9% point. The difference between the mid-point and the key flash point fraction (61.1-59.9) is 1.2 and the yield, from Fig. 3, is 17.5%.

6. Calculate the viscosity at 100° F. of the indicated yield by dividing it into four equal fractions, and employing Fig. 5. This viscosity is 250 seconds. The purpose of this step is to determine the effect of broadening the product range.

From the above steps it can be seen that the maximum yield of the desired stock is 17.5% and the position of this fraction in the crude is from 52.3% to 69.8%.

An advantage of the present method is its reproducibility. Where products are blended for flash point and viscosity, a small error in a test may make a considerable error in yield. This error is reduced when calculations are made from curves based on tests on small fractions.

Acknowledgment

The writers would like to thank Messrs. J. W. Newton, W. W. Leach and P. L. Smith for permission to publish this manuscript; and V. A. Kalichevsky for valuable suggestions in the course of its preparation.

References

(1) Kalichevsky, V. A.; Technical Section, *National Petroleum News*, 37, No. 40, R-763—R-764 (1945).

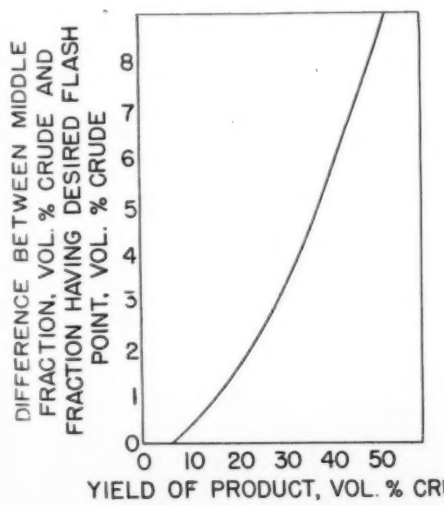
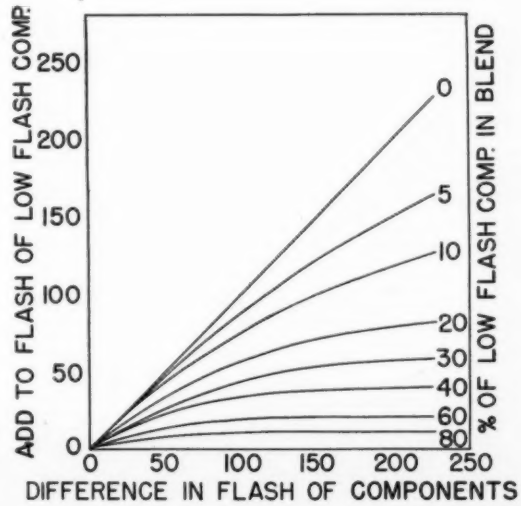
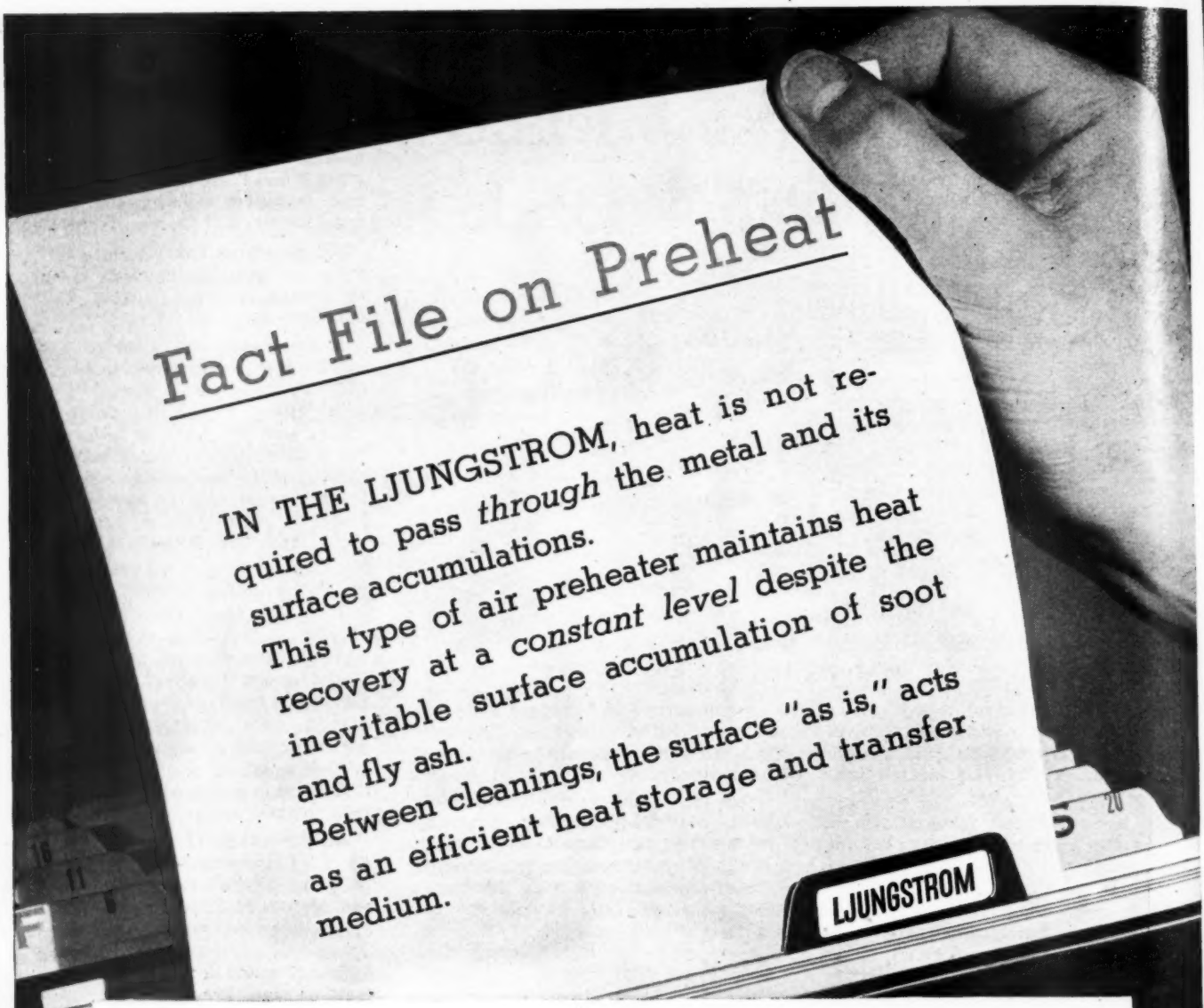

DIFFERENCE BETWEEN MIDDLE FRACTION, VOL. % CRUDE AND FRACTION HAVING DESIRED FLASH POINT, VOL. % CRUDE
0 1 2 3 4 5 6 7 8
0 10 20 30 40 50
YIELD OF PRODUCT, VOL. % CRUDE

Fig. 4 (left—Curve for determining yield of a product of given mid-point and flash point

Fig. 5 (right)—Flash blending chart for lubricating oils


ADD TO FLASH OF LOW FLASH COMP.
0 50 100 150 200 250
0 5 10 20 30 40 60 80
% OF LOW FLASH COMP. IN BLEND
0 50 100 150 200 250
DIFFERENCE IN FLASH OF COMPONENTS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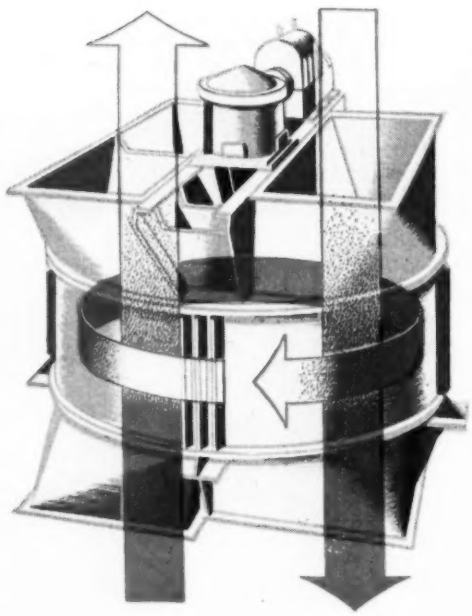

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Plant Practices

Practical Tips and Ideas for Improving Operations

Catalyst Plugging in Lines Is Eliminated By Arrangement of Automatic Air Valves

AN AUTOMATIC "double block and bleeder" valve arrangement serves to good advantage in the operation of the Fluid catalytic cracking unit at the Philadelphia refinery of the Gulf Oil Corp. It uses emergency steam to unplug accumulations of catalyst in the carrier lines.

Shown schematically in Fig. 1 and illustrated in the photograph, the device admits steam to the point where the catalyst line from the reactor joins the carrier line. The three air-actuated valves are controlled automatically by conditions within the unit. Whenever a slug of steam is needed to eliminate an unplugged condition, the built-up air pressure on the diaphragms of the valves opens them.

Under normal operating conditions, the 3-in. valves A and B remain closed and the 1-in. valve C is open so as to bleed off any possible flow of steam. Under emergency conditions, valve C closes first and then valves A and B open, sending steam into the carrier line. The same arrangement also has been incorporated in the recycle catalyst lines of the Fluid unit.

Color Code Provides Record On Heat-treated Hand Tools

COLOR coding adopted for several different purposes has resulted in improved efficiency at the Philadelphia refinery at Atlantic Refining Co. One code serves as a check on tools which have been repaired and heat treated.

As soon as a tool has been through the shop and is ready to be returned to service, a spot of fast-drying, long-wearing lacquer is daubed on it. A new color is used each month according to a schedule worked out for the entire year. This practice avoids stamping dates into the tool, a procedure which tends to weaken the tool. The schedule for 1947 is typical.

January—Orange.	July—Green.
February—Purple.	August—Brown.
March—Pink.	September—Blue.
April—Lavender.	October—Yellow.
May—White.	November—Gray.
June—Red.	December—Black.

A similar lacquer daub is used to identify stocks of various materials; for example, blue might be used to designate carbon steel, red for one alloy, green for another, etc. The choice of colors is purely arbitrary. A third color code provides identification of plant personnel. "Hard" hats are lacquered a solid color corresponding to the following code: operators, green; mechanical inspection, yellow; plant protection, white; mechanical supervisors, blue; fire brigade, red.

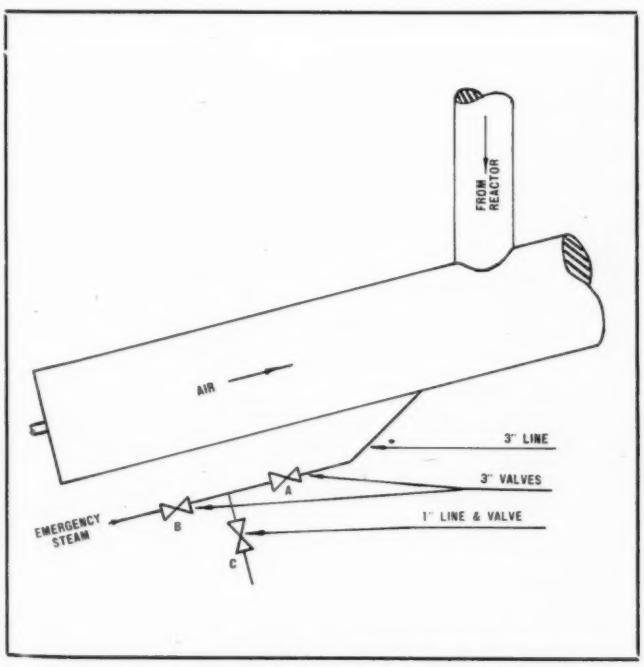
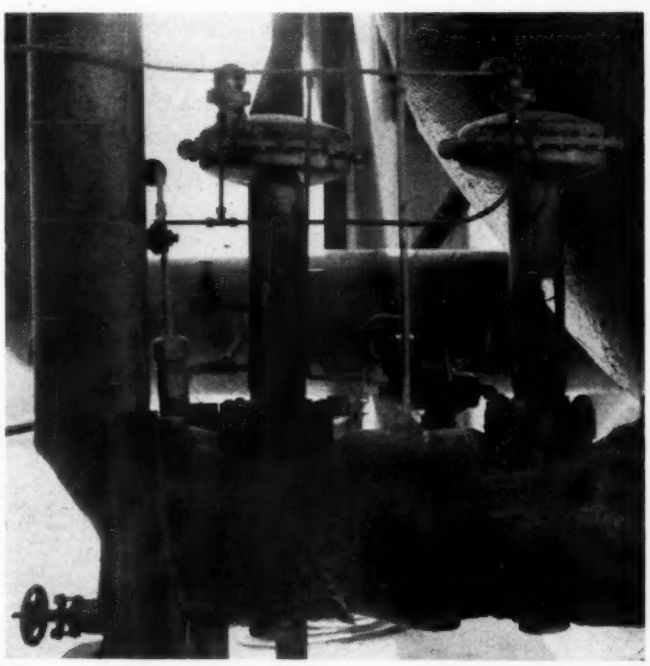


Fig. 1—Schematic arrangement of "double block and bleeder" valves used to unplug catalyst carrier lines on Gulf's Fluid unit



Photograph shows the arrangement as installed in the refinery; two large vertical valves are valves A and B, valve C is hidden between them

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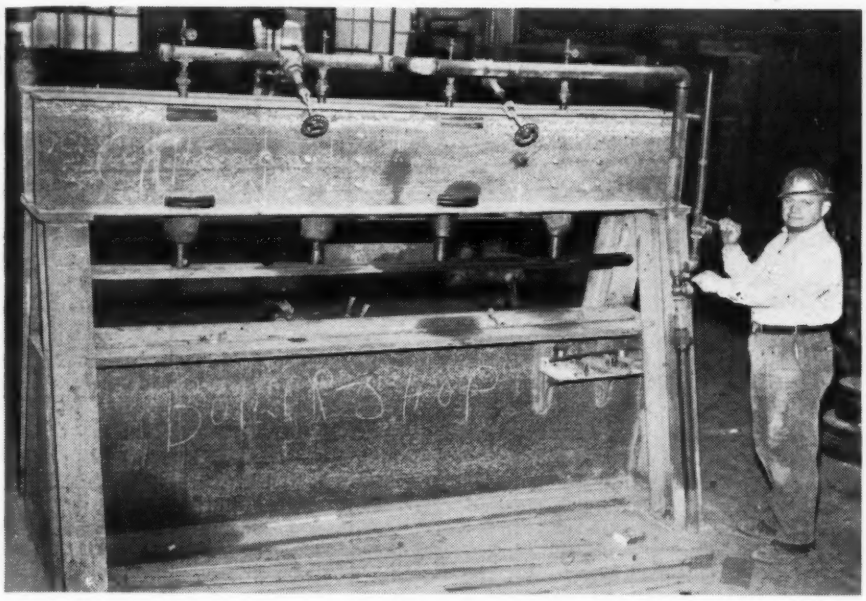


Sinclair Refining Co.'s Marcus Hook maintenance shop used this plate bending press employing four railroad air brake cylinders

UTILIZING conventional railroad air brake cylinders and the plant compressed air supply for power, a plate bending press in the maintenance shops of the Marcus Hook refinery of Sinclair Refining Co. has proved to be of value for a wide variety of jobs.

The accompanying photograph shows the method of construction. Across the top are two pieces of 18-in. "I" beam, each 9 ft. 8 in. long. These are set up side by side and bolted to end "V" legs, each "V" being made of two pieces of 8-in. "I" beam. The angle between the legs is such that the height from the floor to the bottom of the 18-in. beams is 5 ft. A 9 ft. 8 in. length of 36-in. "I" beam serves as a base for the bottom half of the bending dies.

The air brake cylinders are bolted between the 18-in. beams on 2-ft. centers, two being bolted to one beam and two to the other so as to equalize stresses. A 2-in. air line supplies air through a manifold to the four cylinders. One-quarter-inch vent lines provide for release of pressure after bending is completed.

During the past several years since "Ljungstrom" heaters were installed around the refinery, it has been necessary on numerous occasions to bend sheet iron or stainless steel plate into "V" shapes. The plate bending machine was built in the shop to speed up these jobs. A supply of various dies is used frequently for different required shapes. Pieces of 12-gauge sheet iron, 8 ft. long, and smaller pieces of 12-gauge stainless steel can be bent on the press.

Sinclair intends adding two extra air brake cylinders as soon as possible, because at present the press is slightly underpowered for some of the jobs on which it could be used. When the additional cylinders are added the same press will be used by decreasing the distance between centers.

Oil Men Are Lazy!

We have come to the inescapable conclusion that the average oil man is an incorrigible lazybones in some respects. The funny part is that he works twice as hard and uses his head four times as much as anybody else just to figure out gadgets to save his back and his feet, schemes to save time and stop shutdowns, and shortcuts to improve throughput. Also, he's darned proud of this skill.

Now, you lazy geniuses! How about submitting some of your good ideas to PETROLEUM PROCESSING. Include sketches and photographs if possible. Don't worry about how to write it up—the idea is the thing—we'll put on the fancy stuff later.

Plant Practices Editor
PETROLEUM PROCESSING
1213 West Third St.
Cleveland 13, Ohio

Improved Gravity Table Found Useful In Figuring Road Oil Freight Rates

By W. F. KRAUSE and A. C. DYSTRUP
Globe Oil & Refining Co., Lemont, Ill.

RAIL freight rates for road oils and similar asphaltic products are determined on an exact weight basis. This weight must be calculated, either from the gravity and volume at 60° F. or from the same data at loading temperatures. In the latter case, the volume is known—from the capacity of the tank car.

Normally, the corrected gravity up to a temperature of 230° F. can be computed from the gravity at 60° F. by reference to the A. P. I. Hydrometer Indication Tables, and to the extension compiled by Griswold. However, viscous oils are frequently loaded at temperatures above 230° F., at which point existing tables end.

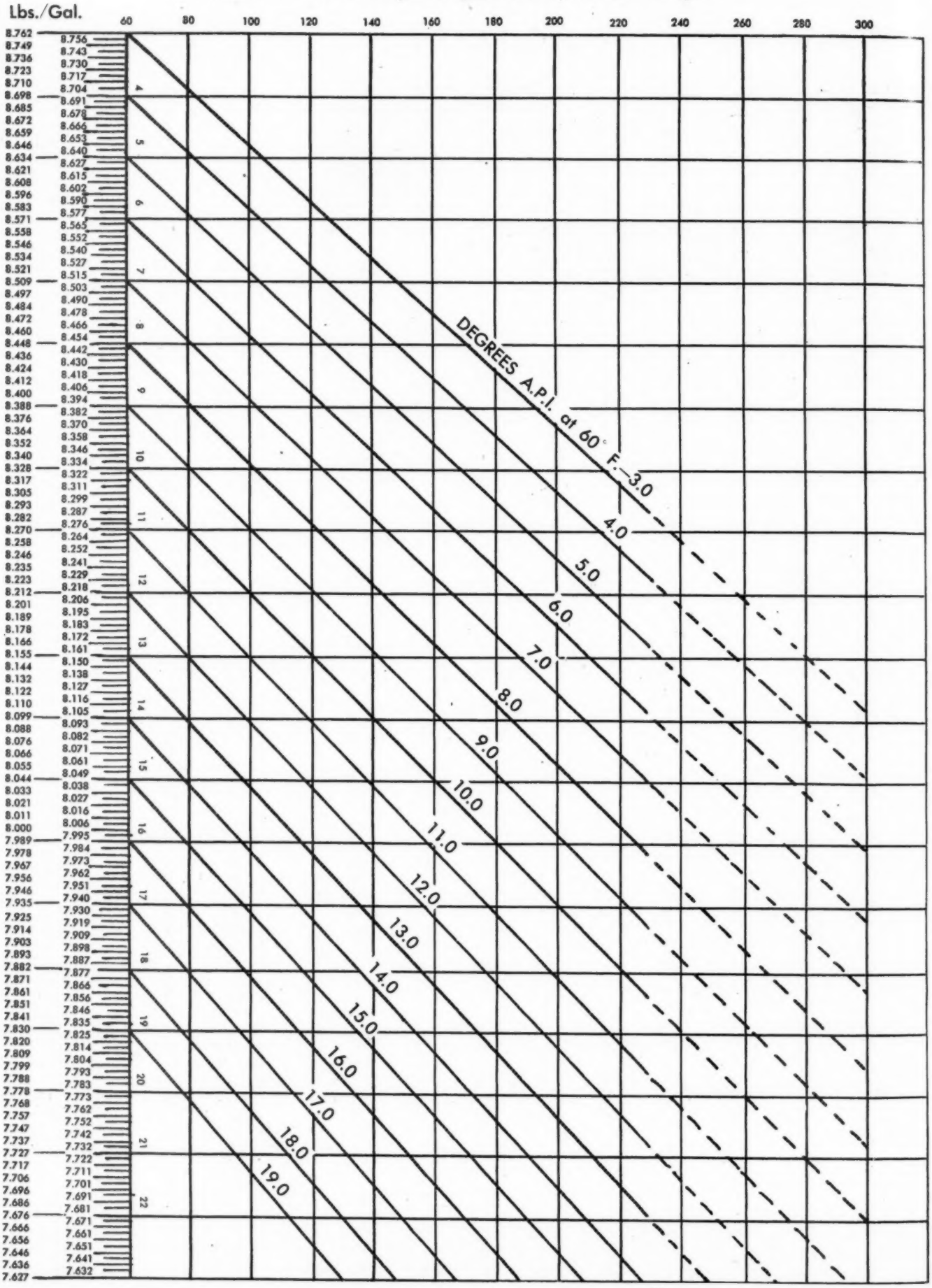
A simple method of extending the tables to these elevated temperatures is by a series of lines in which the API gravity is plotted against temperature. That segment of the lines between 60 and 195° F. is based upon the standard gravity tables; that between 195 and 230° F. upon the extension mentioned previously; and that between 230 and 300° F. upon the assumption that it should have the same slope as the one between 60 and 230° F.

If the weight per gallon corresponding to each 0.10° API also is shown on the graph, then literally at a glance the gravity and weight per unit volume can be read off for any loading temperature from 60 to 300° F.

For example: Determine the gravity and from that the weight per gallon of an oil at a loading temperature of 256° F., if the API gravity of the oil at 60° F. is 8.3. For a solution, follow the graph in Table 1 on page 292.

Follow the 8° API line (closest to 8.3) to the intersection with the 256° F. temperature line. Follow down the vertical line from that intersection to the baseline; this corresponds to 17.5° API. Add 0.3° API (the difference between 8.0 and 8.3). The result, 17.8, is the gravity at loading temperature, 256° F. The weight per gallon (directly below 17.8) is 7.893 lbs.

TABLE 1—API Gravity—Temperature Correction Graph



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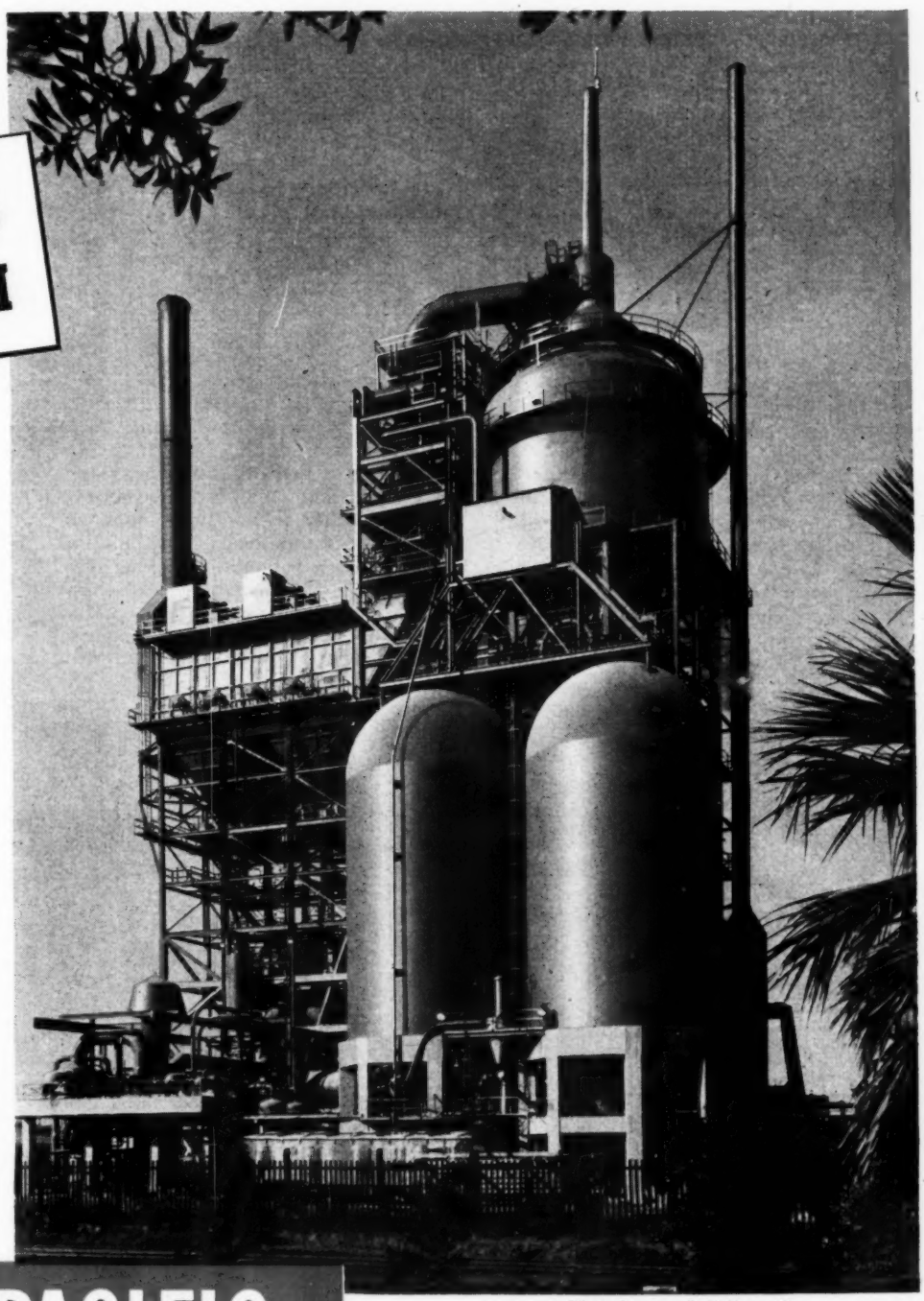

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PR-6

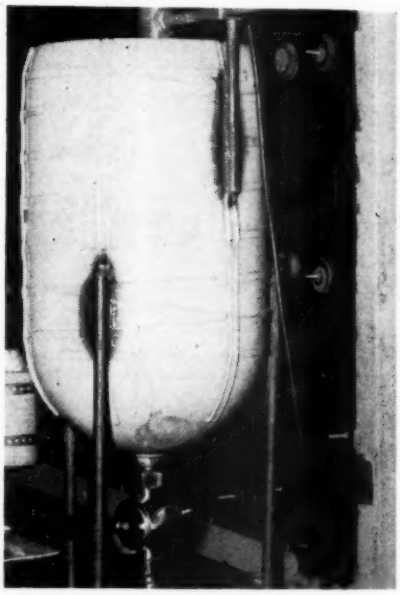
Laboratory Practices

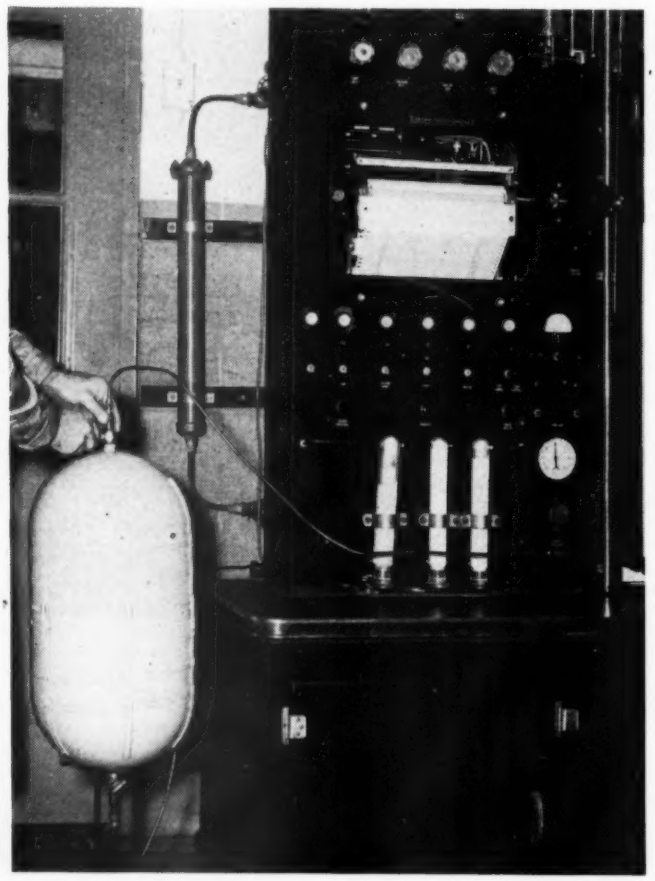
Research Workers Find Practical Use For Walkway Grillwork, Oxygen Tanks

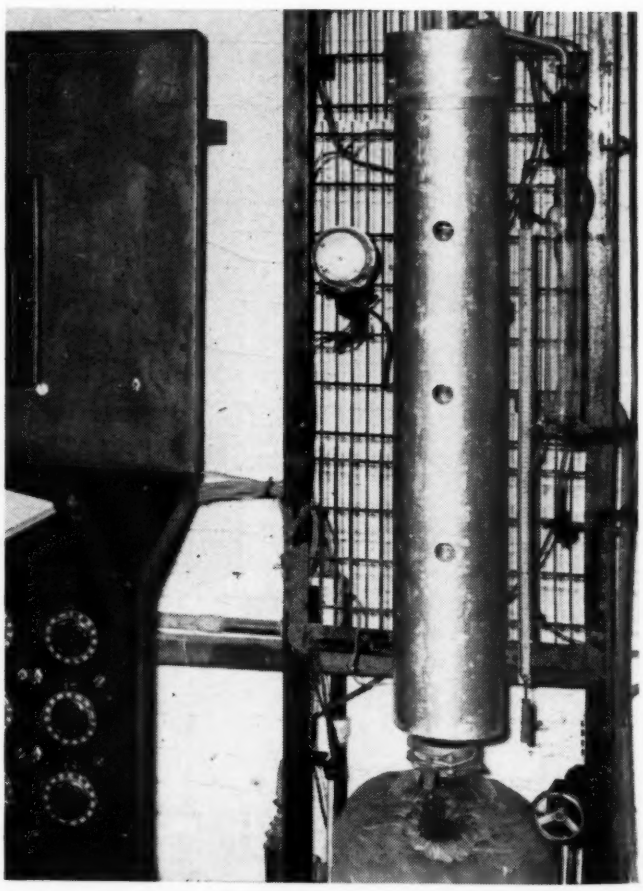
TWO pieces of equipment normally associated with applications a far cry from the research end of the petroleum industry have been used to definite advantage in the Riverside, Ill., laboratories, of Universal Oil Products Co. One is steel grillwork of the type used conventionally for safe walkways on refinery processing units; the other is the small metal tanks used during the war to supply oxygen to bomber crews on high altitude flights.

In the picture at the left below, an oxygen tank is functioning as a container from which gas is being sampled to a gas analysis apparatus in UOP's gas analysis laboratory. This and other applications, such as a constant temperature bath and a glycol bath on condenser cooling systems, were developed by M. J. Stross, manager of this laboratory. The smaller picture at the right shows one these tanks incorporated into an apparatus for preparing catalyst samples.

In the same picture, refinery grillwork has been used to form the bench top as well as the vertical mounting structure. The same type of grillwork has been put to a different purpose in the picture at the right below, where it is shown supporting a large distillation column and stillpot, as well as auxiliary equipment such as a gage, burettes, condensers, and the like.







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Motor-operated Valve Is Found Practical Safety Feature on Hydrogenation Unit

By H. M. STINE and M. M. FINK,
Research Laboratories, Standard Oil Co. (Ohio)

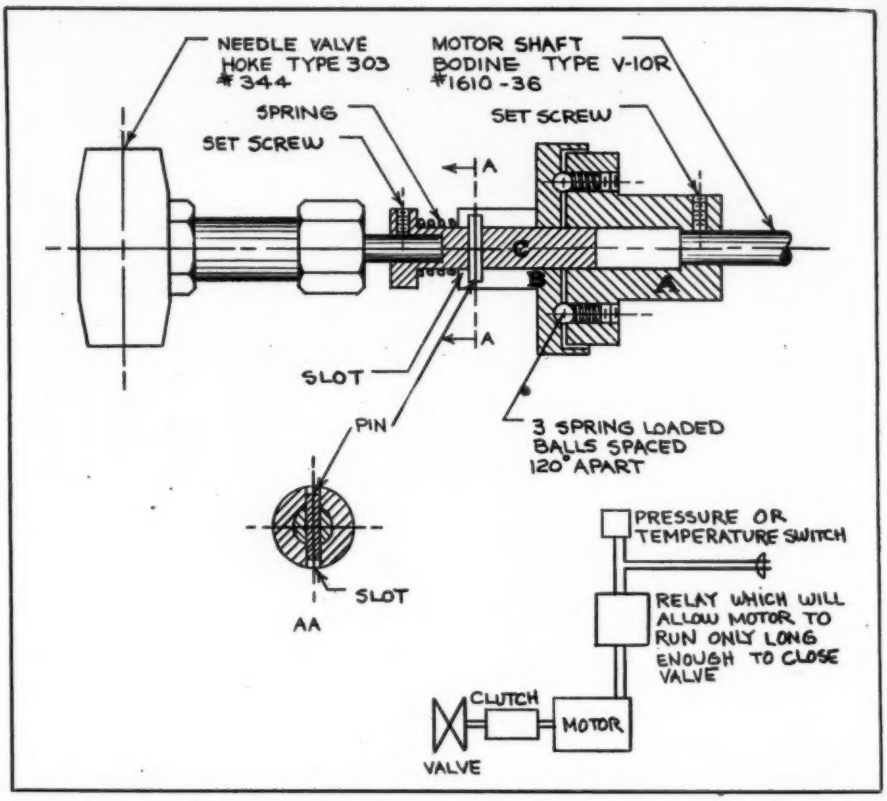

Fig. 1—Laboratory needle valve converted to motor-operation and actuated by pressure or temperature switch

MOTOR-OPERATED valves are used frequently in petroleum refining units, but there usually is no need for them in laboratory units. A laboratory scale, motor-operated valve in use at Sohio's research laboratory was designed as a safety feature for use on a low pressure hydrogenation apparatus which operated for extended periods of time with but little attention.

The valve is actuated by a temperature switch. If a fire occurs on the unit, the temperature switch actuates the motor and closes the valve, interrupting the flow of hydrogen to the unit. The operation of the device may be seen in Fig. 1. Rotation of the motor shaft turns the ball friction clutch, which in turn rotates sliding shaft C. The rotation of C closes the ¼-in. needle valve, shutting off the hydrogen flow.

The valve stem stops turning when the torque required to turn it is greater than the force exerted by the springs holding the balls in the sockets. At that time, part A of the clutch disengages from part B. Rotation of the motor is stopped by a time-actuated relay. Actual motor rotation continues for about 30 seconds after the switch is closed.

It has been found wise to test the valve occasionally to be certain that it turns freely enough for the clutch to close it. The device also can be actuated by elements sensitive to pressure or other controlling variables as desired.

IDEAS—Wanted!

Have you saved time or improved accuracy in the laboratory by some gadget, some new method of your own, some "kink?" Tell us about it. Send in your descriptions, photographs, sketches, too. If accepted, we pay at our usual space rates. Mail them to:

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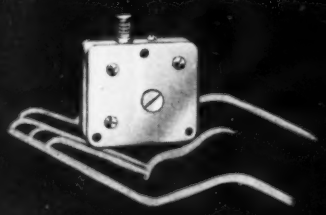
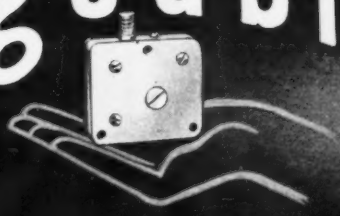
AN "EYE-OPENER" IN



Interchangeability



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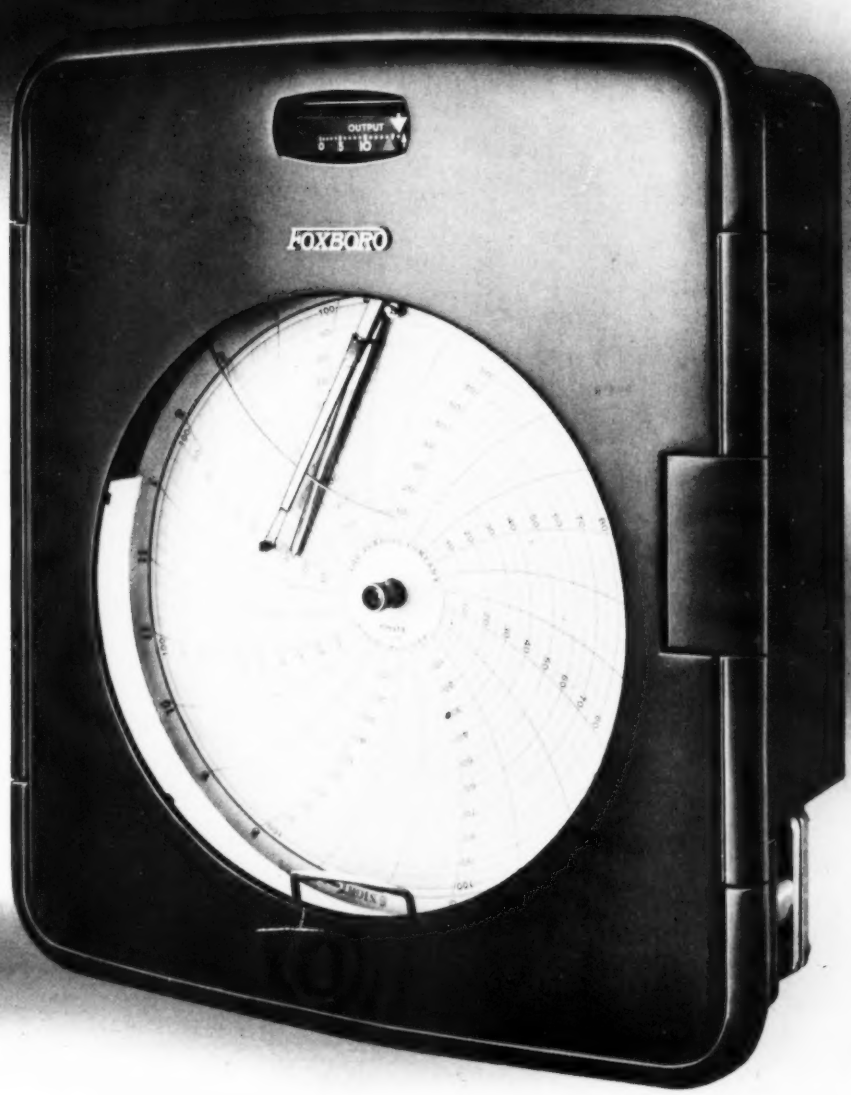
This interchangeability of parts is no happenstance. Every part was designed to eliminate variations that might necessitate critical field adjustments . . . and vital parts were built to machine tool precision. In the eyes of expert instrument men, interchangeability is another important advantage that makes M-40 the outstanding modern controller.



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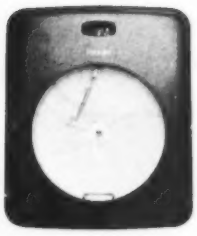
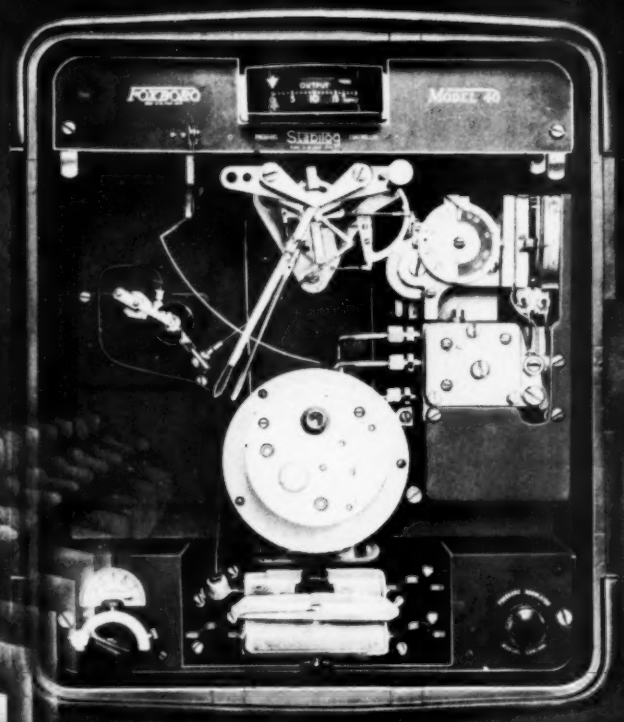
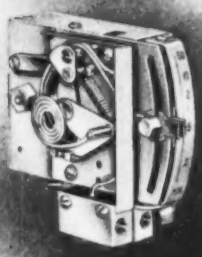
M-40

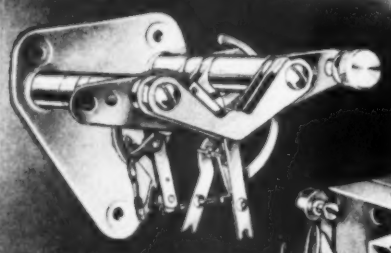
"THE FINEST MODERN CONTROLLER"

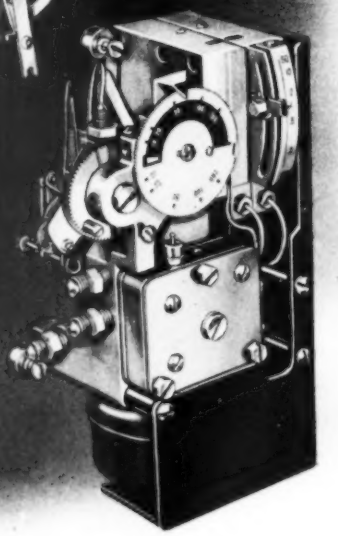


The Model 40 Pneumatic Controller is available for temperature, pressure, flow, liquid level, humidity, density, etc., in a full range of control actions and combinations. Write for Bulletin 381. **The Foxboro Company, 262 Neponset Avenue, Foxboro, Mass., U. S. A.**









Identical Performers

. . . because simple, unit construction makes duplication of parts easy

All main and sub-assemblies of the Model 40 Controller may be interchanged freely without impairing the accuracy and stability of the instrument. If, for example, the control relay should ever need replacing, another may be easily substituted with positive assurance that it will restore the original performance characteristics.

A closer examination of the control relay shows that its design and construction are so basic, so free from complicated parts and critical adjustments, that there are no manufacturing problems in turning out duplicate performers. It also shows that proper alignment of control relay with other parts is automatically assured.

This advanced engineering, typical of M-40 design and construction, is another important reason why M-40 is the finest modern controller.

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"THE FINEST MODERN CONTROLLER"

Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Data in answer to questions presented on these pages is supplied through the cooperation of authorities with the equipment and engineering companies of the Natural Gasoline Supply Mens Assn., among others. Readers are invited to submit queries on plant operating problems in their own work.

What are the symptoms of improperly functioning traps and suggested steps for correcting them?

Traps often give trouble in operation because they are not properly located or installed. In general, they should be placed in plain view to promote observation during operation and easier maintenance. "Hidden" traps are often overlooked. Inlet and outlet connections cannot be interchanged and good gravity drainage is desirable but not vital. The trap should be installed level and upright.

Lines should be blown out thoroughly before installing traps. Strainers are recommended in "dirty" service. Be sure to prime the trap following installation or maintenance unless the liquid back-up in the inlet line will do so automatically.

Below are listed some symptoms of trap difficulties and remedial measures. Many of the remedies are obvious when the cause is known.

Trap does not discharge:

1. Inlet line obstructed.
2. Bypass valve open or leaking.
3. Inlet pressure exceeds trap rating, due to system changes or improper rating of trap used.
4. Accumulation of foreign matter in trap.
5. Defective trap mechanism.

Trap does not shut off:

1. Trap undersized or held open by defective mechanism.
2. Foreign matter under valve.
3. Condensate load has increased over that anticipated on installation, resulting from: boiler foaming and priming, leaking steam coils in submerged service or underestimation of condensate load.

Trap blows steam:

1. No prime. This may result from failure to prime following installation or maintenance.
2. If inverted bucket type, trap is greatly oversized and seal eventually will be blown.
3. Open or leaky bypass valve often causes traps to lose their prime.
4. Mechanism failure, resulting from worn or damaged parts or presence of foreign matter and will cause traps to blow steam.

Condensate fails to drain from system:

1. Trap inlet pressure insufficient to force condensate through trap.
2. "Short-circuiting" where trap drains several units.

Trap capacity suddenly decreases:

1. This can be due to reduction in differential trap pressure. The differential pressure reduction can be caused by reduced inlet pressure or increased back pressure, or both. The back pressure increase may be due to line obstructions, other traps blowing steam and open or leaking bypass valves.
2. Abnormal volume of air slows up trap operation. Where abnormal air volumes are present the trap may be too small, but may be sufficient if thermal bypass is installed.—Bob Molnari, Eggelhof Engineers, Houston.

What is the best source of information on the toxicity of alkaline boiler blowdown water?

It is my understanding that the questioner is confused about the term "toxicity", whether as applied to human beings or aquatic life. Its general use conveys the idea of poisonous effects upon either human beings or, if the question is one pertaining to water pollution, to aquatic life.

I have done a great deal of toxicity work in the Waste Control Laboratory here in Philadelphia, but never have had occasion to carry on definite studies of the toxicity of boiler blowdown water. My own reaction would be that it is not too serious. I cannot refer the questioner to any place in the literature where this information would be available and I believe your question can be answered only by using standard toxicity tests of the variety most pertinent to the specified problem. I would advise care in selecting a test procedure for, unless it is of a nature which will best serve the specified purpose, the results can be very misleading.

While I have given no definite information, if the writer will specify the conditions prompting the question I will be glad to go further in attempting to obtain some definite results.—W. B. Hart, Waste Control Laboratory, The Atlantic Refining Co., Philadelphia.

What effect does oil entrained in natural gas have on the life of solid adsorbents? How can these effects be minimized and are there other suggestions for prolonging desiccant life?

Entrained oil or vapors definitely reduce the effective life of solid adsorbents as these vapors are adsorbed and, by coating the porous adsorbent particle, interfere with moisture adsorption. Usually the temperature required for desorbing them is higher than the usual reactivation temperature employed. Also, if this temperature is too high, there is danger of depositing carbon on the adsorbent from thermally cracking this residue or of natural gas under high pressure, which likewise interferes with its power to take up moisture. Natural gasoline, if present, also will be adsorbed. Hammerschmidt(1) gives some interesting data on these points, as shown in Tables 1 and 2.

There seems to be no standard procedure to prevent vaporized compressor lubricants or absorber oil from entering dehydrator towers—the obvious solution to the difficulty. At a

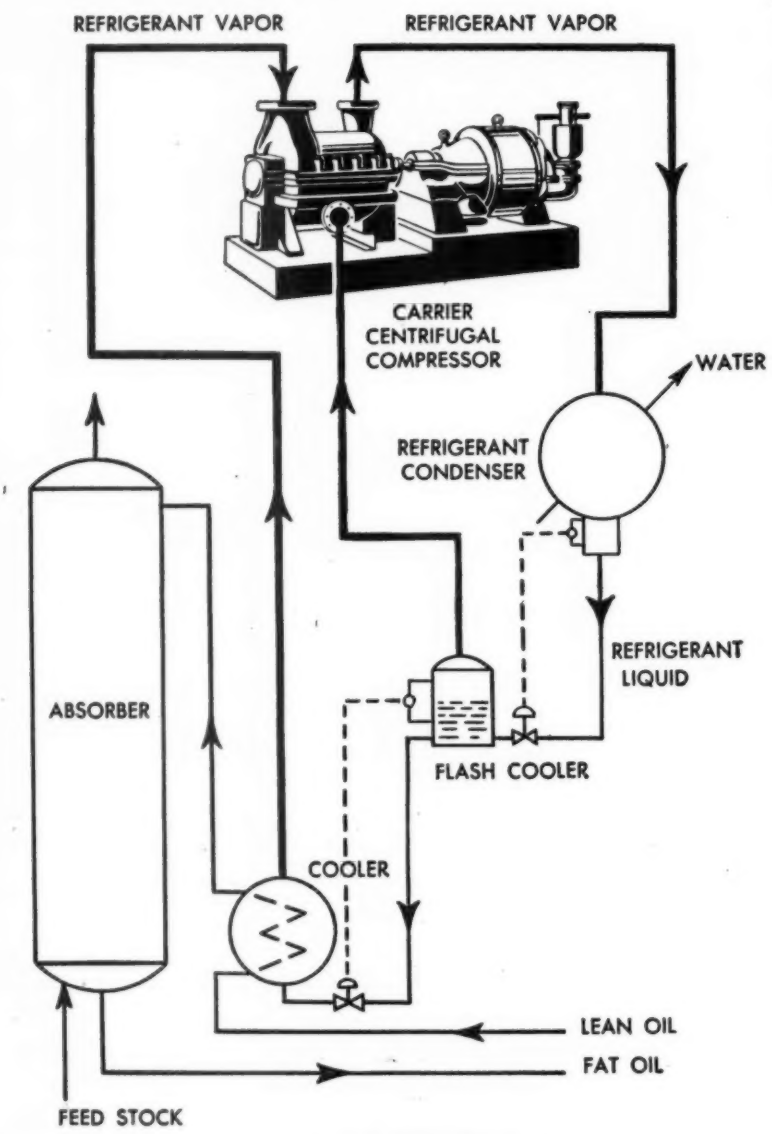
TABLE 1—Vapor Phase Adsorption of Oil and Natural Gasoline

Vapor phase oil adsorption by alumina	1st Adsorber In Series	2nd Adsorber In Series
Temp. of adsorber outlet gas, ° F.	74	74
Alumina Bed Temp. ° F.	84	65
Pressure on Alumina Tubes, Psig.	737	737
Time of contact, seconds	11.6	12
Water adsorbed, Wt. %	7.7	5.0
Oil adsorbed, Wt. %	0.15	0.38
Oil adsorbed, Lbs./Million cu. ft.	0.82	2.17

PROBLEM:

How to get higher butane and propane recovery

SOLUTION:



Refineries and Natural Gasoline Plants have found the use of Carrier Centrifugal Compressors with hydrocarbon refrigeration cycles highly effective for higher butane and propane recovery at lower costs. The advantages of a Carrier Centrifugal in this application are many, for instance:

1. **It permits lower absorber pressure with savings in gas compression.**
2. **It reduces lean oil circulation, with corresponding economies in distillation and steam requirements for stripping. In many cases, sufficient steam is saved to power the turbine that drives the compressor.**
3. **It is extremely compact.**
4. **It provides unusually trouble-free, dependable operation year after year.**
5. **Installation costs are lower, for the Carrier Centrifugal Compressor can be operated without housing, expensive foundations or even piling.**

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Carrier **CENTRIFUGAL COMPRESSORS • REFRIGERATION EQUIPMENT**

TABLE 2—Natural Gasoline Adsorption by Sova Beads and Florite

% Gas Passed Through Adsorbent*	Sova Bead Res. Gaso. Cont. By Charcoal Test. G.P.M.	Florite Res. Gaso. Cont. By Charcoal Test. G.P.M.
Start	.264	.308
18.9	...	.327
25.9	.327	...
47.2	.350	.350
100.0	.353	.340

* Inlet gas contains 0.327 gal. per Mcf. by charcoal test.

recent regional N.G.A.A. meeting(2) a desiccant manufacturer's representative suggested the use of precontactors, mechanical separators or both ahead of the drying tower to knock down this objectionable material.

The precontactor may be either a horizontal or vertical vessel, filled with an adsorbent material to remove the oil vapors or entrained particles. This might well be some of the spent desiccant from the drying towers, a crushed porous firebrick or similar material. When observation indicates oil vapors are coming through again, this material is dumped and a new charge of spent desiccant added. A stand-by precontactor is valuable in maintaining continuous protection to the drying towers, and no change need be made in the latter's operation.

Since a mechanical separator is most satisfactory where particles of entrained oil (or water) are to be removed, it is suggested for use ahead of a precontactor only where such conditions may exist. For example, following an absorber where considerable oil is lost overhead and to minimize widespread contamination of the desiccant in the event of a "puke."

Hammerschmidt states that the reasons behind the gradual, permanent decline in adsorptive capacity of solid desiccants upon repeated regenerations are not clearly understood but regeneration temperature and possibly time, presence of moisture (as steam) and heavy hydrocarbons are important factors. He suggested that near the time when laboratory studies predict the desiccant at the wet gas entry point has permanently lost most of its water holding capacity, the intake be switched to the other end of the tower. Gains in effective life up to 30% are shown in his data using this operating wrinkle, which indicate that desiccant at this point loses most of its adsorption power first, and that at the gas exit point is last in this respect.

Maher(3) advocates admitting regeneration gas to the top of vertical dehydration towers, especially when wet gas normally enters the bottom. This prevents water vapor, liberated from the bottom desiccant layers, being readsorbed in the upper layers as regeneration proceeds, until the entire bed has attained a temperature at which water cannot be readsorbed under the particular regeneration conditions employed. — Dave Thornton.

References

(1) Hammerschmidt, E. G., "Dehumidification of Natural Gas," N.G.A.A. Panhandle-Plains meeting, Amarillo, Dec. 10, 1949.
(2) Panhandle-Plains Meeting, Amarillo, Dec. 10, 1948, and private discussion.
(3) Maher, J. L., Prepared Discussion, N.G.A.A. Southern meeting, Shreveport, Oct. 15, 1948.

What are the most important factors to consider in the proper selection of steam, air, gasoline and oil draining traps?

The most common difficulties with traps arise from misapplications rather than from mechanical shortcomings. Too often traps are selected with only the pipe size and pressure requirements in mind. Little regard is paid to: 1) Whether or not the correct type of trap is selected; 2) the quantity of fluid to be drained. and 3) the speed at which this quantity should be discharged.

1 What type should be used?

There are three general types of mechanical traps; namely, the inverted bucket, open or upright bucket and the float type. Almost any one of these will do an average job on general drainage service, but certain particular types will serve best on certain applications.

The open bucket trap is particularly recommended 1) where there are pulsating pressures, since the bucket is unaffected by pulsations; 2) where there are wide fluctuations in both pressure and condensate load; and 3) where incondensible gases, such as air, natural gas, etc. are present because an equalizing line can be installed to preclude the possibility of a vapor lock in the trap. They are particularly recommended for draining water, gasoline, oil, ammonia from pipe lines, separators, tanks, and the like.

The inverted bucket trap is especially suited for 1) steam lines and equipment where abnormal amounts of air must be discharged; 2) frequent on-and-off service; and 3) where dirt, sludge and oil drain to trap with the condensate. Generally, they are not recommended for other than steam service.

Both the open and inverted bucket traps, because of their intermittent discharge, produce a highly desirable "purging action" which reaches back into the system to pull pocketed air and condensate down to the trap and insure maximum system efficiency.

Float traps are used where continuous flow is required, on such applications as refinery reboilers and heat exchangers regulated by thermal controllers and where the purging action of the bucket traps would be undesirable. They, likewise, are especially recommended for draining liquids from air and vapor carrying lines where the discharge of any gas or vapor would be objectionable or even dangerous. This is because the discharge valve is always liquid sealed.

2 What is the condensate load?

The normal amount can be approximately calculated by numerous methods, many of which are found in the various trap manufacturers' catalogs and engineering handbooks. Using the Btu. rating of the equipment to be drained by the trap is probably the easiest method. A rough "rule of thumb" method is to allow 1 lb. of condensate for every 1000 Btu.

Loads generally vary and abnormal situations will and do occur. Water slugs may develop from boiler foaming, priming, or pocketed condensate suddenly set in motion. Abnormal amounts of air and condensate must be handled when starting up cold equipment. Therefore, a "safety factor" must be used in trap sizing. Trap manufacturers recommend that a factor should never be less than 2 to 1 and may even exceed 8 to 1 in some situations. Tables suggesting approximate safety factors for various types of installations are available in trap catalogs or on request.

A large "safety factor" will oversize the trap and increase purging action where desirable. On intermittent or "batch" service, either an oversize trap or the installation of an auxiliary thermal bypass will reduce the "warm-up period" materially to increase equipment production.

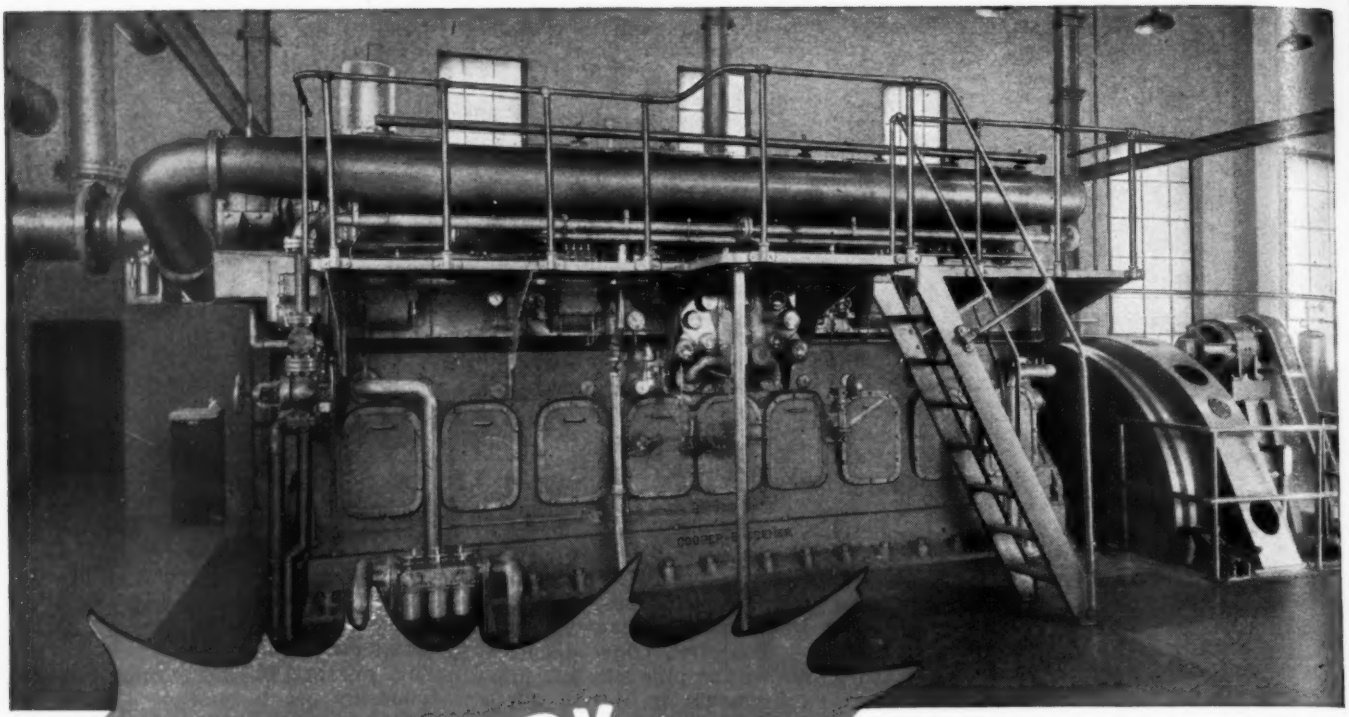
Traps are rated by their continuous flow per hour at various trap differential pressures, which means the maximum amount of discharge per hour. Multiplying the condensate load by the safety factor selected gives the continuous flow desired.

The difference between the trap inlet and outlet pressure gives the trap differential pressure. Where there are wide fluctuations in trap differential pressure, the maximum and minimum should be determined.

3 What size trap of the type selected?

Using the desired continuous flow capacity at the *minimum* trap differential pressure, the correct seat orifice diameter is easily found in the manufacturers' tables.

In the table listing the pressure ratings of the type trap selected, find a rating corresponding to, or the next one above, the *maximum* trap differential pressure. Under pressure rating selected, find the nearest orifice size to that already determined as being required and this will tell the number and size of the correct trap. —J. L. Mainwaring, Clark Manufacturing Co., Cleveland.



HISTORY IN THE MAKING

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Patent Trends in Petroleum Refining

By PETER J. GAYLOR, Editor "The Technical Survey"

Layer of Activated Carbon on Treating Clay Reduces Its Rate of Degradation

IN U. S. PATENT 2,449,016 issued to Socony-Vacuum Oil Co., Inc., a process is disclosed that is claimed to give a regenerated clay from treating petroleum oils which is even more efficient than the original fresh clay, and one which does not suffer progressive degradation in efficiency with each regeneration.

The process involves treating acid refined oils with a finely divided porous adsorptive clay carrying an outer layer deposit of not less than 2.5% of activated carbon resulting from the incomplete combustion and removal of petroleum oil. In actual practice, the spent clay is regenerated in a controlled atmosphere, the essential feature being to restrict sufficiently the amount of air in the zone so that complete combustion or oxidation of the petroleum products will not occur. Steam may be admitted to the carbonizing zone to facilitate removal of hydrocarbon vapors and reduce the rate of carbon build-up in the clay. Apparently, the carbon layer acts to protect the clay during this operation. The amount of carbon required for protection of the clay varies somewhat upon the oil stock processed through it.

Experiments on typical clay indicate that, if contaminated percolation clays are wet with steam or water and then heated to normal regenerating temperatures of the order of 900° F. or higher, a loss of about 1% in decolorizing efficiency results. Then, if the clay is cooled, re-wet and then reheated a further 1% decrease in decolorizing efficiency again results. In other words, repeated cycles of wetting, heating and cooling will each be accompanied by a 1% decrease in decolorizing efficiency. It has been demonstrated that the presence of certain quantities of carbon on the clay will protect it from the detrimental effects of sequential wetting, heating and cooling by conventional regeneration methods.

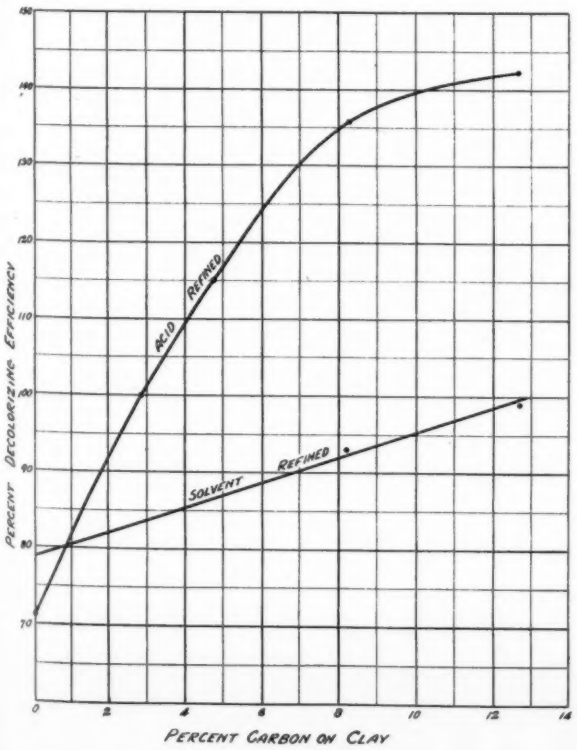

Fig. 1 — Ratio of decolorizing efficiency to quantity of carbon by weight

The ratio of decolorizing efficiency to quantity of carbon by weight is expressed graphically in Fig. 1, in which the abscissa represents percentage by weight of carbon on clay and the ordinate represents percentage of decolorizing efficiency (the values being based on burned fuller's earth as 100% efficient). The line marked "Acid refined" indicates that not only is the clay protected against degradation in efficiency incident to 20 wetting-heating-cooling cycles, but that its clean burned efficiency for acid refined oils is actually enhanced if the ratio by weight of the carbon to the clay is in excess of 2.5%. On the other hand, the line marked "Solvent refined" in the drawing indicates that the maintenance of efficiency for that type of oil requires about 2.5% by weight of carbon before any appreciable advantage over the uncarbonized clay is noted, and about 12% for the prevention of efficiency loss as compared to new clay.

The importance of the clay regeneration problem to refiners is to be seen from the fact that over the U. S. roughly 5000 tons of petroleum filter clay are regenerated each day with attendant degradation inefficiency. Furthermore, each year the petroleum industry purchases about 225,000 tons of new fuller's earth alone, representing an expense of over $4,000,000, and discards to waste roughly 200,000 tons of clay considered too spent to warrant regeneration.

In general, three different methods are used for refining petroleum oils with clays. These are the percolation process where liquid oil is percolated through granules of the clay; the contact process where liquid oil is contacted with finely pulverized clay and vapor process where oil vapors are passed through granules of the clay.

In all these methods, after the clays have refined a certain amount of oil they become so contaminated with carbonaceous impurities that they must be regenerated or discarded. Usually, contact clays are

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discarded after the first use, and once-used vapor process clays are thereafter employed in percolation. Accordingly, in practice, generally only granular percolation clays are regenerated. Regeneration has been effected principally by a chemical oxidation which universally consists of burning off the impurities.

When regeneration becomes necessary, it is not the usual practice to pass the clay directly to regeneration, either in the same container or in another operation, since it carries a very considerable amount of the oil with which it has been in contact. If the oil is volatile, it is customarily removed by steaming. A heavy oil is customarily removed by washing with a lighter, volatile oil, the residue of which, in turn, is also removed by steaming. This operation, called a "steam purge," is common throughout the industry.

Various methods have been used for carrying out the burning of granular spent clay. One of the earliest involves spreading the clay on an open hearth and burning it. Today three methods are in general use. In the first, the clay falls or cascades over baffles set at about a 45° angle through a flue countercurrent to gases of combustion. In the second method, the clay is regenerated in a rotary kiln slightly inclined from the horizontal. In the third, probably the most commonly used, mutiple hearth burners are employed. These multiple hearth furnaces or burners are substantially the same as are used in the roasting of ore and are of either the Nichols-Herreshoff or Wedge type. The clay is slowly rabbled across each hearth, dropping from one to another until the bottom hearth is reached.

In all these conventionally used methods there is a progressive degradation in the efficiency of the clay with each burning. Finally, the clay must be discarded to waste since it is no longer capable of being regenerated sufficiently to warrant further treatment.

In general, granular petroleum filter clays are regenerated only 7 or 8 times and practically never more than 10 or 15 times, when their efficiency is reduced to about 50% of the original and they are thrown away. As stated above, the finely pulverized contact clays, e.g., 200 mesh or finer, which are less frequently used, are practically never regenerated.

While undoubtedly progressive degradation results from the uncontrolled burning of contaminants deposited on the clay, it appears from recent experimental work, that this tendency is at least augmented by the prior wetting of the clay as an unavoidable incident of the steam purge.

Processing Patent Abstracts

Process for separating hydrocarbon gas from a mixture by using liquid absorbent under superatmospheric pressures and cooling to temperature low enough to retain desired gas in liquid absorbent. U. S. 2,451,-136; Herman H. Wenzke to Universal Oil Products Co.

Process for extraction of acetylenes from hydrocarbon gases containing diolefins, by passing in presence of hydrogen over a treated aluminum silicate catalyst. U. S. 2,451,327; Egi V. Dasce and William H. Wood to Standard Oil Development Co.

Method for dewaxing an oil-wax mixture with a solvent comprising a mixture of toluene, nitrobenzene and o-nitrotoluene and a cerophile liquid paraffinic hydrocarbon. U. S. 2,451,545; Seymour W. Ferris to Atlantic Refining Co.

Improvement in fluid catalytic cracking process, comprising passing one stream of hot regenerated catalyst directly into stripping zone where it is intermingled with catalyst from the conversion zone. U. S. 2,451,619; Robert J. Hengstebeck and Robert S. McDaniel to Standard Oil Co. (Indiana).

Method for chlorination of paraffinic hydrocarbons by contacting methane with mercuric chloride vapor at 500-650° C. U. S. 2,451,821; Everett Gorin to Socony-Vacuum Oil Co., Inc.

Oxidation of isobutane to peroxidic compounds by reacting a gas of isobutane, oxygen and hydrogen bromide, periodically reactivating the reaction vessel walls with nitrogen dioxide. U. S. 2,451,869; John C. Rapean and William E. Ross to Shell Development Co.

Continuous catalytic synthesis of hydrocarbons from CO and hydrogen in two reaction zones, withdrawing spent catalyst from first zone and introducing into second at higher temperature to remove oily and waxy material. U. S. 2,451,879; Walter G. Scharmann to Standard Oil Development Co.

Solvent extraction of mercaptans by catalytic addition of hydrogen sulfide to an olefin, subjecting resulting crude mercaptan oil to extraction with a sodium hydroxide-methanol-water solvent, removal of mercaptans in pentane. U. S. 2,452,040; Harry E. Drennan to Phillips Petroleum Co.

Desalting crude oil by passing through a settling chamber of fiber glass. U. S. 2,454,605; Chalmer G. Kirkbride and Mark C. Hopkins to Pan American Refining Corp.

Alkylation process which comprises passing feed stream in contact with stream of catalyst through a reaction chamber having permeable walls, introducing olefin fluids through permeable walls, to impose a relatively catalyst-free barrier at the walls of the reaction chamber. U. S. 2,454,869; Arthur R. Goldsby and Claude W. Watson to The Texas Co.

Continuous method for making candles by flowing the candle stock successively through chilling, extruding, candle forming and cooling steps. U. S. 2,457,088 Ernest F. Pinney to Socony-Vacuum Oil Co.

Process for polymerizing propylene with a phosphoric acid catalyst, isolating olefins with more than 10 carbon atoms, recycling the lighter polymers. U. S. 2,457,146; Henry W. Grote, Robert L. Swoope and Charles S. Brearley, Jr., to Universal Oil Porducts Co.

Improvement in the stripping of spent catalyst in catalytic cracking operation through the control of temperature in the stripping zone. U. S. 2,457,255; Paul F. McElherne to Standard Oil Co. (Indiana).

In the alkylation process, subjecting the hydrocarbon mixture from alkylation to prefractionation to separate the lower boiling unreactive hydrocarbons and a portion of the excess isoparaffin as overhead, and succeeding to other fractionation steps. U. S. 2,457,564; Ludwig Kniel to Lummus Co.

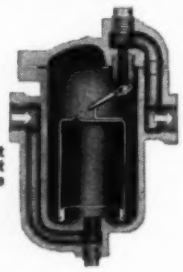
Moving bed catalytic cracking of fluid hydrocarbons by introducing the fluid charge into a stream of downward moving catalyst in particle form in a conversion zone, the lower portion of which is baffled at several levels to form a continuous tortuous solid-free passage for gas flow. U. S. 2,458,165; Herbert K. Holm to Socony-Vacuum Oil Co., Inc.

Continuous recovery of xylidines by the liquid phase catalytic hydrogenation of nitro xylenes, using a finely divided nickel catalyst. U. S. 2,458,-214; Mott Souders Jr. to Shell Development Co.

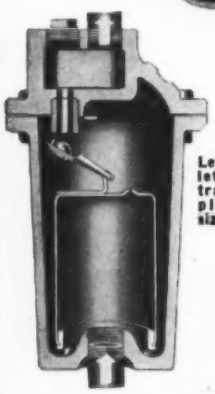
In moving bed catalytic cracking a series of patents covering mechanical improvements in the regeneration of the catalyst. U. S. 2,458,356-357-358-359; Louis P. Evans to Socony-Vacuum Oil Co., Inc.

In a multicomponent separation process, control of the process in accordance with light absorption characteristics: Where the predominant component of each product stream

CHOICE OF BODY STYLES

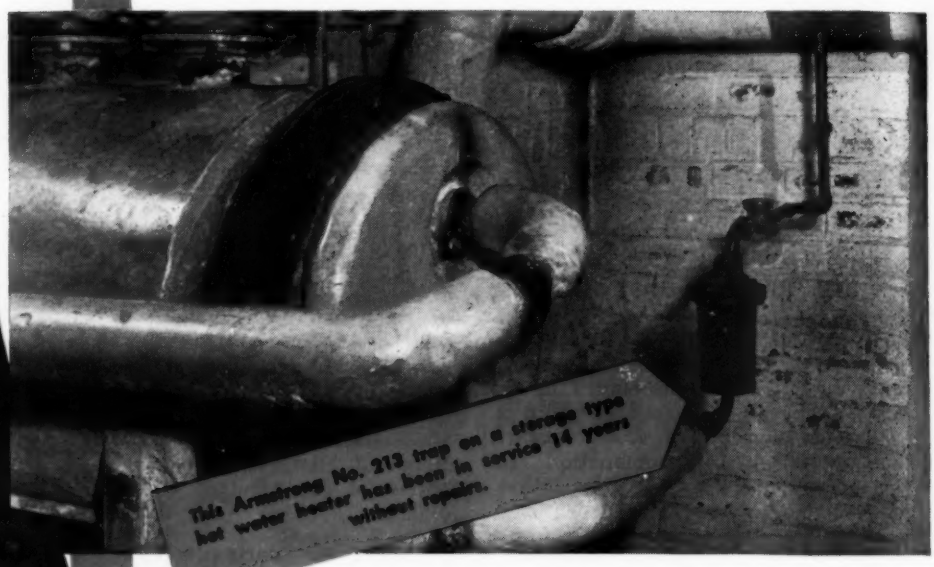


Right: Side Inlet — Side Outlet traps for in-line installation.



Left: Bottom Inlet — Top Outlet traps in a complete range of sizes.

WHY ARMSTRONG TRAP MECHANISMS *last so long!*



This Armstrong No. 213 trap on a storage type hot water heater has been in service 14 years without repairs.

WHAT USERS SAY

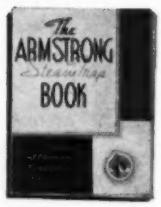
36 Armstrong Traps on heating system service in an Atlanta building still going strong without maintenance after 10 years.

* * *

One minor repair job in 20 years —that's the record of the Armstrong traps in service at South Dakota hospital.

* * *

Standardization on Armstrong traps slashed maintenance—first trap operating over 15 years without repairs—Canadian foundry.



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The user of standard Armstrong steam traps for medium and low pressure service reaps the benefit of the research, investment and experience that went into the development of Armstrong forged steel traps for high pressure generating station service.

The valves and seats in all Armstrong traps are chrome steel, hardened, ground and lapped to a precision fit. The inverted buckets and valve lever assemblies are all corrosion resistant 18-8 stainless, heavily reinforced for wear. In normal service these mechanisms often last for years without attention. And when a valve finally wears to the point where it fails to seat properly, it is usually good for a relapping—a job any maintenance man can do in a few minutes. Or replacement is a simple, inexpensive job.

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ARMSTRONG STEAM TRAPS

has a distinctive absorption characteristic for different wave lengths of light, analyzing the product stream and obtaining electrical potentials, which potentials are employed in the control of the separation process. U. S. 2,459,404; James A. Anderson to Standard Oil Development Co.

In moving bed catalytic cracking, an improvement consisting of introducing the gaseous reactant into the contact zone in a plurality of levels and also withdrawing the reactant products from a plurality of levels. U. S. 2,458,411-412; John W. Payne to Socony-Vacuum Oil Co., Inc

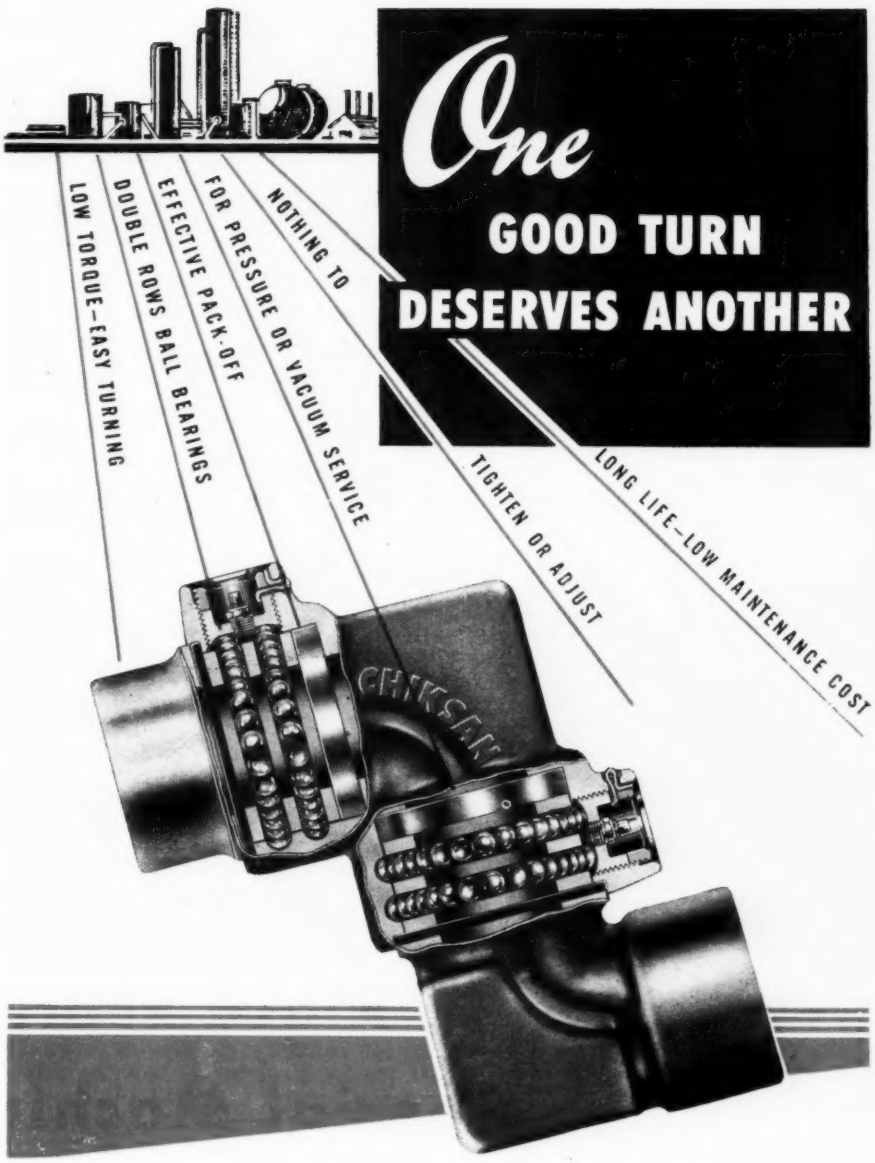
Synthesis of high octane motor fuel hydrocarbons by reacting CO with hydrogen in presence of an iron catalyst, treating a fraction from resulting hydrocarbon-rich phase with an alumina catalyst. U. S. 2,452,121; James H. Grahame to The Texas Co.

In the Fischer-Tropsch synthesis, an improvement which comprises insuring good fluidization of the powdered iron catalyst by mixing with it powdered inert material of larger particle size but lower density to obtain a homogeneous mixture in the reaction zone. U. S. 2,459,444. Thomas C. Main to Standard Oil Development Co.

Two-stage hydrogenation process, comprising, in the first stage, reacting hydrogen-containing gas and a gas oil containing aromatics, sulfur and nitrogen, at elevated temperatures and pressures, with a catalyst sulfide of metals of Groups VI and VIII of the periodic system to convert the nitrogen and sulfur compounds to volatile compounds, removing these compounds; passing the product to a second reaction zone, where it is contacted with hydrogen and a sulfur-sensitive catalyst, recovering a product of lower aromaticity and having substantially the same boiling range. U. S. 2,459,465; Warren M. Smith to Standard Oil Development Co.

Hydroforming a virgin naphtha, by reacting it at elevated temperatures and pressures with a catalyst consisting of a heavy metal oxide of Groups V and VI of the periodic system, carried on a suitable support, said catalyst before use having been subjected to about 720 cycles of oxidation and reduction at elevated temperatures. U. S. 2,459,480; Albert B. Welty, Jr., and Clinton H. Holder to Standard Oil Development Co.

Alkylation process using as a catalyst a double fluoride compound of hydrogen fluoride and a fluoride selected from the group consisting of the fluorides of the alkali metals, alkaline earth metals, and ammonium. U. S. 2,459,775; Herbert J. Passino to the M. W. Kellogg Co.



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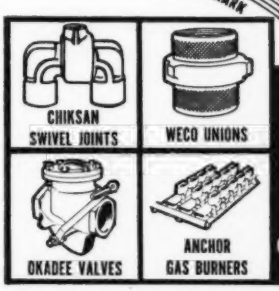

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Kiln Cooling Tubes Not Needed When Catalyst Is "Recycled"

In addition to the catalyst stream recycling conveyer described below; this month's review of new and improved devices used in petroleum processing and handling operations on which patents have been issued recently includes:

- **Screw feeder eliminates need for tall catalyst legs**
- **Tube temperatures equalized in improved exchanger**
- **Pump runs more smoothly using inclined inlet ports**

COOLING TUBES in the regenerator of a moving-bed catalytic cracking unit can be eliminated, or substantially reduced, by an arrangement whereby a portion of the regenerated catalyst stream is cooled and then "recycled" back to the kiln. Close temperature control can be obtained by admitting this recycle stream of cooled catalyst to any one of a number of points in the regeneration vessel, as desired.

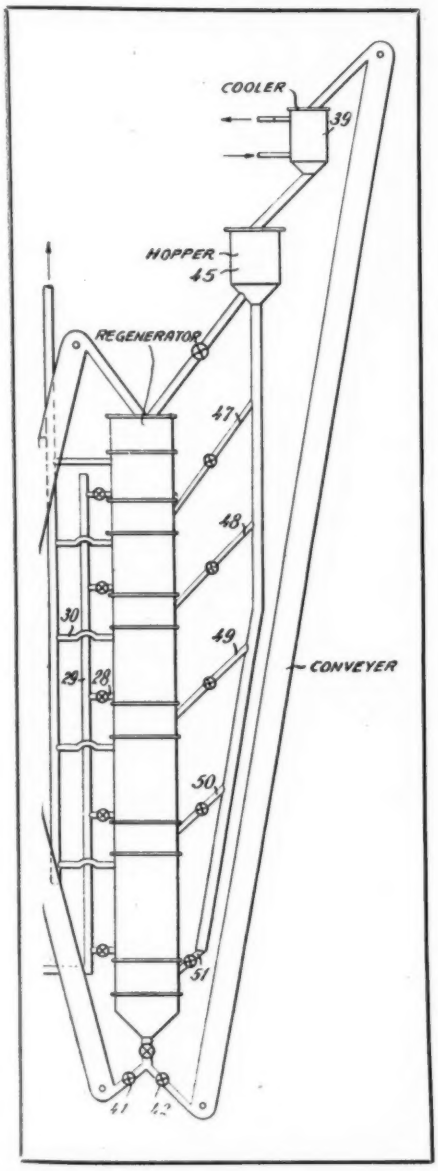


Fig. 1—Recycle stream of regenerated and cooled catalyst enters the kiln via any one of several lines, 53, 47, 48, 49, 50, or 51 (U. S. 2,458,350)

The equipment is illustrated diagrammatically in Fig. 1. Normally, regenerated catalyst returns to the reactor via valve 41; however, a portion of the stream is allowed to pass through valve 42 and is then conveyed up to a cooling hopper 39. This cooler may be of either an indirect or a direct heat transfer type. No specific gas is designated at the coolant, but it is preferred that the catalyst be brought down to about 200° F.

Catalyst then passes through surge hopper 45 and is admitted to the kiln as required by lines 53, 47, 48, 49, 50, or 51. Conventional burning air enters the regenerator through manifold 29 and valves 28. Spent flue gases leave via lines 30 and the exhaust manifold. An alternative design embodies the use of a reduced number of cooling coils in the regenerating zone.

The chief advantage of this equipment over conventional design, it is stated, is in the high rate of heat transfer between the cold and hot particles of catalyst. In addition, it tends to discourage excessive localized burning usually encountered in the case of heavy contaminants.

U. S. 2,458,350, issued Jan. 4, 1949, to John A. Crowley, Jr., assignor to Socony-Vacuum Oil Co., Inc.

Screw Feed Eliminates Need For Tall Catalyst Seal Legs

GAS SEAL can be maintained in the transfer of catalyst from zone to zone in a cracking unit without employing a tall sealing leg and without crushing the grains of catalyst. Tall seal legs, it is pointed out, are uneconomical because of their effect on the overall height of the unit structure. In addition, crushed catalyst grains usually result in waste through carryover of fines with the products.

The feeder or transfer device is shown in Fig. 2. It consists of a rotor comprising a pair of concentric cylindrical drums, all mounted on top of the reactor 40. The inner drum 2 has fins 6 and is shorter than the outer drum 1, with the end walls substantially flush at the discharge.

The feeder operation is similar to a helical feed screw mechanism. The catalyst gravitates to the lower sections of the coil, becoming compacted and forming, in effect, a series of sealing legs sufficient to maintain the required pressure differential. At the same time, pinching and crushing of the catalyst is kept to a minimum.

U. S. 2,457,461, issued Dec. 28, 1948, to Johan E. A. Graae, assignor to The Lummus Co., New York.

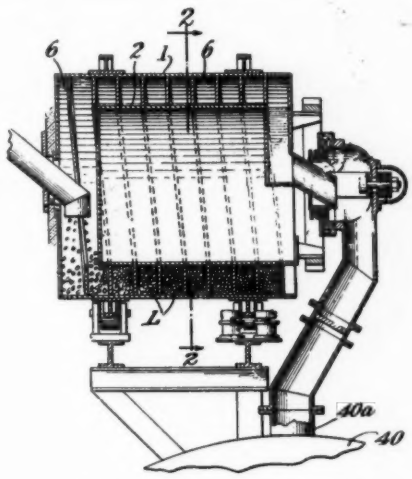


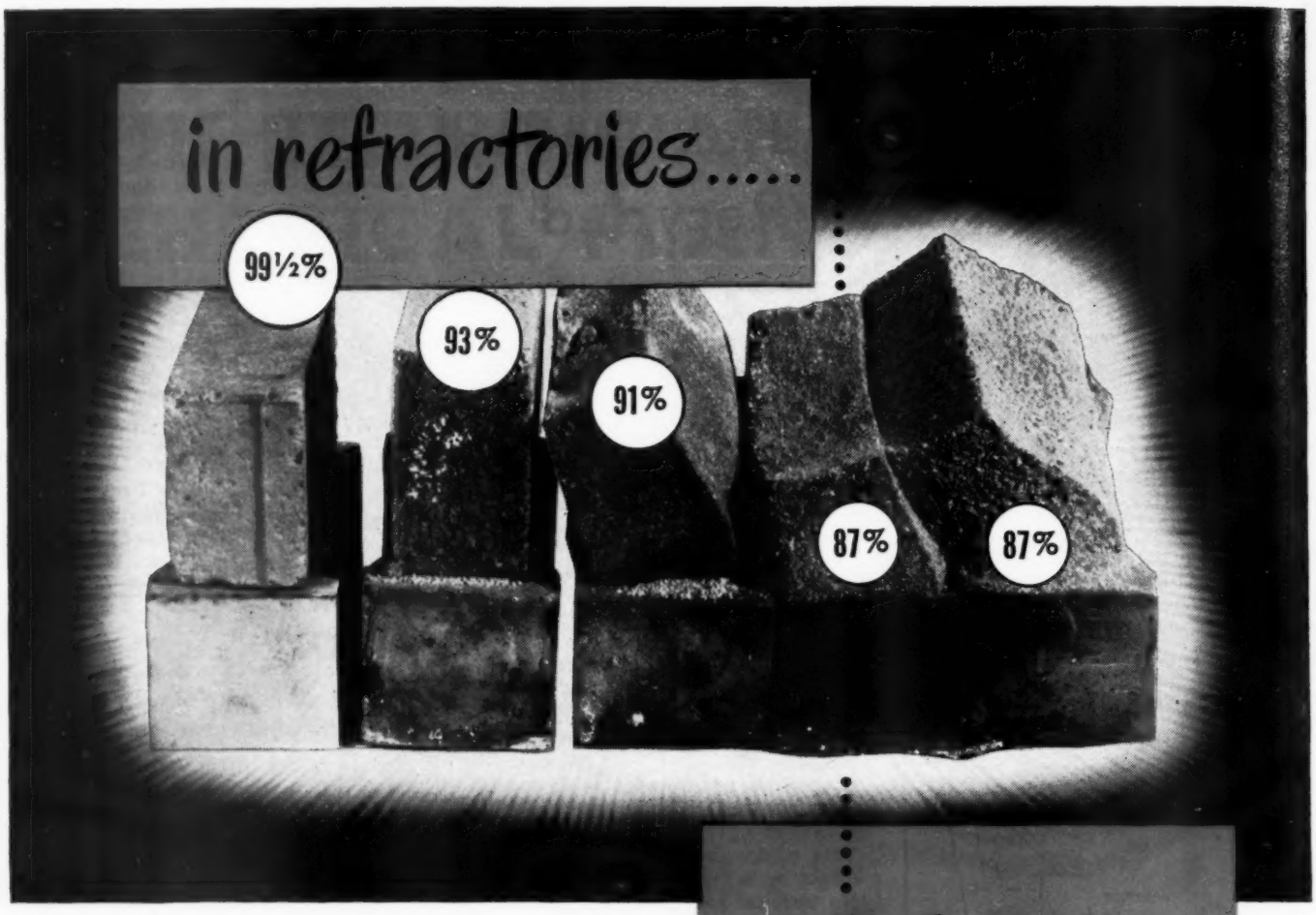
Fig. 2—Catalyst transfer device eliminates need for tall seal legs and reduces crushing of catalyst particles (U. S. 2,457,461)

Tube Temperatures Equalized In Improved Heat Exchanger

COOLING EFFECT of exterior chamber walls on a tube bank in a heat exchanger can be reduced substantially by placing a set of baffle plates just inside and spaced slightly away from the walls, to provide for a regulated flow of heating medium. The improvement is reported to be particularly useful in connection with the reactor cell of a butane dehydrogenation unit.

The arrangement is shown in Fig. 3. Control of the heating medium flow to the narrow space 13 between plate 12 and wall 6 is accomplished by a sliding, slotted strip which opens and closes a series of orifice slots at the upstream end of the space 13.

Slots 14 are controlled by bar 16 which has a handle outside the exchanger chamber for manual regulation. By this means, the temperature differential between the outer and in-



a little more Alcoa Alumina makes a "Whale of a Difference"

ALCOA Alumina increases stability and high-temperature resistance of refractories. This is clearly shown in the specimens illustrated above. All are alumina-content brick, and all were held at a temperature of *3400° F.* (Cone 40, flat) for four hours. From left to right, the alumina content of each brick is: 99½%, 93%, 91%, 87% and 87%. You can see what a "whale of a difference" a little extra ALCOA Alumina makes. (As temperatures and alumina content are decreased, similar results are obtained.)

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(Photo and data: Courtesy of Richard C. Remmey Son Co.)

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ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

ner tubes of a relatively compact bank of tubes is eliminated. Temperatures are equalized throughout the bank, resulting in a more uniform product from the process.

U. S. 2,458,756, issued Jan. 11, 1949, to Charles C. Watson, assignor to Universal Oil Products Co., Chicago, Ill.

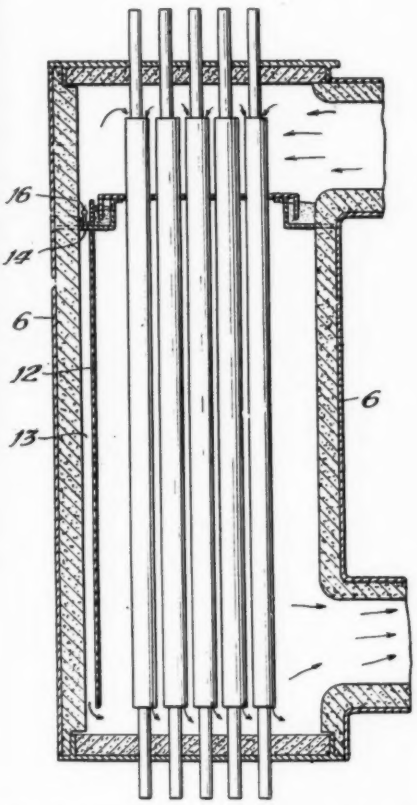

Fig. 3—More uniform temperatures are provided in heat exchanger through use of baffle plate 12 and controlling openings 14 (U. S. 2,458,756)

Inclined Inlet Ports Provide Smoother Pump Operation

INCLINED PORTS in the periphery of the ring gear in a gear pump or compressor are said to overcome present disadvantages of conventional pumps of this type so that operation can be had under high discharge pressure with minimum leakage and shock loss.

The design is shown in cross section in Fig. 4. Obliquely inclined ports 22 provide a wedge-shaped pickup lip 23, which merges into the tooth flank 25 without angular break or discontinuity. As a result, fluid is in effect scooped up during rotation of the ring gear and, in flowing along the face of the advancing tooth, is evenly accelerated to the speed and in the direction of rotation of the ring gear.

With the normal peripheral form of inlet in which the ports are radial, there is an abrupt direction change

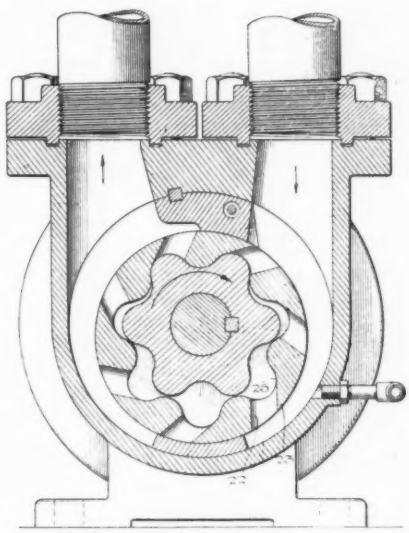

Fig. 4—Peripheral inlet ports 22 are slanted; improve efficiency of gear pump ring gear (U. S. 2,458,958)

which creates considerable shock loss resisting the complete filling of the inner tooth space.

U. S. 2,458,958, issued Jan. 11, 1949, to Reginald J. S. Piggott and Ernest A. Mori, assignors to Gulf Research & Development Co.

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest

Catalytic Conversion Unit for the dehydrogenation of butylene to form butadiene, in which the desired shorter reaction time is attained by quenching the reactants with cooled catalyst, and in which also the catalyst is fed to the reaction zone through an upflow standpipe. U. S. 2,458,960, issued Jan. 11, 1949, to B. E. Roetheli and W. G. Scharmann, assignors to Standard Oil Development Co.

Continuous Chlorination Apparatus for gaseous hydrocarbons in which the halogenation is promoted by means of a fluorescent light. U. S. 2,458,691, issued Jan. 11, 1949, to Julian Dorsky, G. W. Mattson, and C. M. Neher, assignors to Ethyl Corp.

Counterflow Catalytic Cracking unit in which undesirable "channeling" is reduced by use of catalyst feed ducts

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(a) The castings shall conform to the following requirements as to chemical composition:

	GRADE "F"
Chromium, per cent	25.0-28.0
Nickel, per cent	10.0-12.0
Manganese, per cent	0.50-1.25
Silicon, per cent	0.25-1.75
Sulphur, maximum per cent	0.05
Phosphorus, maximum per cent	0.05
Carbon	Within limits of Paragraph 4 (c)

(b) The chemical limits for all other added alloying elements, such as molybdenum, titanium and nitrogen, shall be specified by the manufacturer. The material shall conform therewith.

CREEP STRESS AND CERTIFICATE:

(a) The indicated creep rate of the material shall not exceed 1% in 10,000 hours when stressed by a tensile load not less than the following:

TEMP. °F.	STRESS PER SQ. IN. 1% CREEP IN 10,000 HOURS GRADE "F"
1400°	4200#
1500°	3700#
1600°	3200#
1700°	2600#
1800°	1950#

(b) Manufacturer shall submit standard creep data and residual physical properties made on material of his own manufacture and certified by an ACCREDITED LABORATORY. The chemical analysis of the creep test specimens shall be reported, including nitrogen content and any other special alloying elements.

TENSION TEST FOR DUCTILITY AFTER HEATING:

(a) Each heat shall conform to the following requirements as to tensile properties after the specimen has been subjected to a temperature of 1400° F. for 24 hours and furnace cooled to 400° F. Test shall be made at room temperature.

	GRADE "F"
Tensile Strength, min.lb./sq.in.	80,000
Yield Strength, min.lb./sq.in.	35,000
Elongation in 2", min. per cent	9.0

Copy of complete specification will be mailed upon request

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Equipment Patent Review

and baffling. U. S. 2,459,056, issued Jan. 11, 1949, to Kenneth M. Watson, assignor to Sinclair Refining Co.

Catalyst Stripper said to have improved efficiency because greater dilution of particles in the stripping gas is maintained. U. S. 2,458,866, issued Jan. 11, 1949, to H. Z. Martin, assignor to Standard Oil Development Co.

Automatic Drainage System for removing condensed hydrocarbon vapors from the flexible fabric seal in a floating roof storage tank. U. S. 2,457,763, issued Dec. 28, 1948, to John H. Wiggins, Chicago, Ill.

Insulated Spherical Storage Tank for liquefied natural gas at approximately atmospheric pressures without loss due to evaporation. U. S. 2,456,195, issued Dec. 14, 1948, to J. O. Jackson, assignor to Pittsburgh-Des Moines Co., Pittsburgh.

Moving-bed Catalytic Cracker in which space velocity is regulated by varying catalyst bed depth in the reactor by means of vertical feed pipes consisting of concentric sleeve valve pipes with orifices at several arbitrary levels, each of which can be opened at different settings of the sleeve valve. U. S. 2,457,093, issued Dec. 21, 1948, to Thomas P. Simpson and Louis P. Evans, assignors to Socony-Vacuum Oil Co., Inc.

Pipe Grinder comprising a self-contained power drive; the entire assembly capable of being mounted on the end of a large diameter pipe for grinding down the ends, which have been roughly beveled by a cutting torch. U. S. 2,455,762, issued December 7, 1948, to Oll R. Hall, Wichita Falls, Texas.

Bubble Cap Assembly utilizing a quick action coupling between the cap proper and the riser so as to facilitate removal and replacement. U. S. 2,457,398, issued December 28, 1948, to David S. Roberts and Robert A. De Luca, Boston, Mass.

Balancer and Leveling Mechanism for one type of movable piston, gas holder storage tank. U. S. 2,457,762, issued December 28, 1948, to John H. Wiggins, Chicago, Ill.

How to Obtain Patents

Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from: The Commissioner of Patents, Washington 25, D. C.

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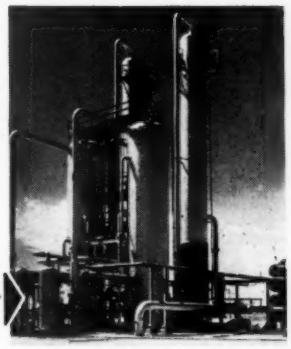
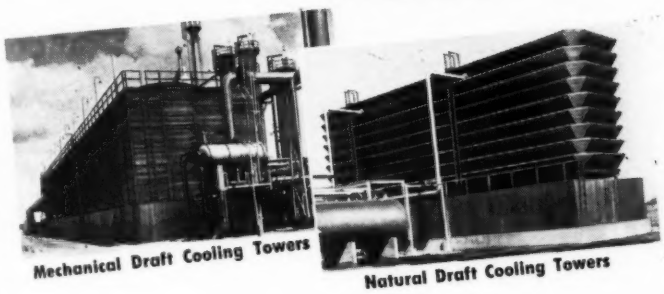


Units and Additions



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Natural Draft Cooling Towers

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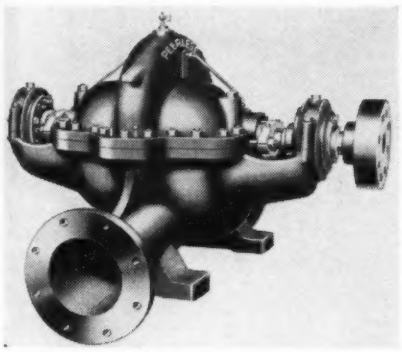
What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by WILLIAM C. UHL, Equipment Editor

1—High Capacity Pump



The Peerless Type A line of horizontal centrifugal pumps features a wide capacity range up to 60,000 gpm against heads up to 300 ft. and is designed for general purpose pumping of water and alkaline fluids at temperatures up to 300° F. Pumps are of single stage, double suction, split case design and available in sizes from 1¼ through 48 in. They are furnished regularly in cast iron, but may be obtained in steel, bronze, or other alloys. Upper half of the case is provided with water seal pipe to the stuffing boxes, air vents, and lifting eyes. Drain plugs are provided in the lower half. Stuffing boxes each utilize 5 to 6 rings of graphited, braided, asbestos packing. Impellers normally furnished in bronze, but available in other materials. Shafts are SAE 1035 rolled carbon steel, machined all over accurately to gage. Grease lubricated ball bearings are provided, except for 30-in. and above; these sizes are equipped with babbitt-lined sleeve bearings and ball thrust bearing. Peerless Pump Div., Food Machinery & Chemical Corp.

For More Information

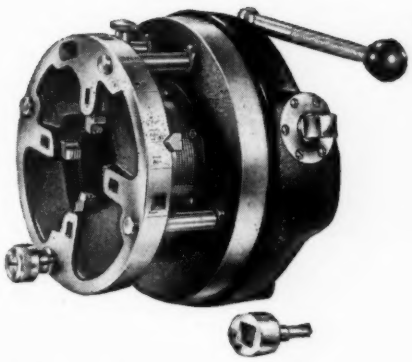
Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. No postage required.

2—Spark Advance Meter

A new electronic spark protractor that measures continuously and accurately average spark advance of 6 and 8-cylinder engines is said to be particularly useful for determining the fuel octane requirements of the new high compression ratio engines under road load conditions The protractor's dial has 250 degrees of arc, scaled to record from 10° retard to 60° advance, and is accurate to ± 1/2°. It operates directly from a 6-volt battery; however, measurements are unaffected by engine speed or battery voltage. The instrument also is furnished in combination with an engine tachometer for metering rpm. Photocon Research Products.

3—Portable Pipe Threader

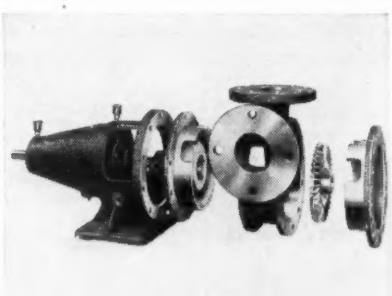
The Armstrong No. 165 Portable Power Pipe Threader can be carried from job to job by one man and be operated in many out-of-the-way



places, close to walls, under limited headroom, or in narrow trenches. It is operated by any ½-in. standard electric drill, and threads 1, 1¼, 1½, or 2-in. pipe with one set of chasers. Entire unit weighs 26 lbs. The threader is furnished with one set of chasers and a drive adapter. Armstrong Bros. Tool Co.

4—Corrosion-resisting Pump

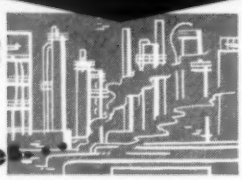
Ready delivery from stock is claimed by the manufacturer for the new Roth stainless steel turbine type pump, designed for corrosives-handling in refineries and chemical plants. Pumps are self-venting and will not vapor bind and will develop high pressures in a single stage. Capacity range is from 2 to 180 gpm. against 0 to 400 ft. head in water. Other features described include renewable heads, a single stuffing box, and a separable pump end. Roy E. Roth Co.



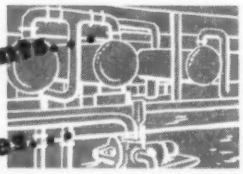
More "What's New!" Items, p. 314

EXCEL-SO
SEPARATORS

HAVE A PLACE IN...

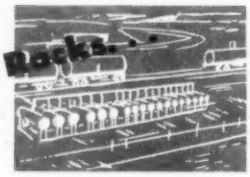


Refineries...



Bulk Plants...

Pipe Lines...



Loading Racks...

Deliver *clean, dry* petroleum products from storage. Excel-So Separators are guaranteed to deliver products 99.99% free of water and pipe scale, muck, and debris down to 25 microns. Recommended for fueloil, diesel fuel, Butane-Propane, gasoline, kerosene and other light oils.

USE THIS COUPON

WARNER LEWIS COMPANY
BOX 3096P - TULSA, OKLAHOMA

Please Send Full Information re: EXCEL-SO Separators

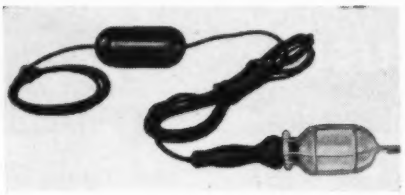
EXCEL-SO

Name _____

Street _____

City _____

5—Safe Extension Light



"Saf-T-Lite" is a portable, step-down transformer which can be inserted in the line of an extension light and that will prevent electrocution often caused by accidental grounding of such lamps The unit reduces a 110 volt circuit to 6 volts, and is available also in a slightly larger model designed to reduce 220 volts to 32. Small in size and weighing 4¼ lbs., the unit looks like a large black capsule. The transformer is protected by a water-proof bakelite casing. Etraco Mfg. Co.

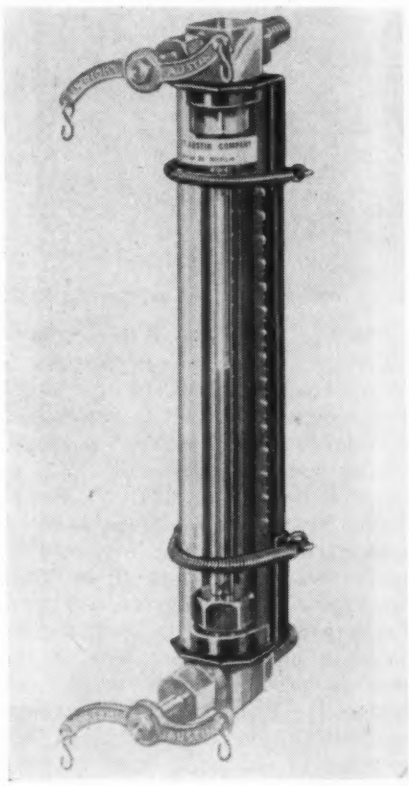
6—Percolation Clay

Attapulgus "AAA" Grade Clay has been shown by tests in a large refinery to have high efficiency as a fullers earth for percolation filter use. With most oils, the material has shown 10 to 20% more refining efficiency, according to the manufacturer, and it maintains this increase throughout its service life. AAA Grade Clay is now available in standard percolation meshes, in bag or bulk. Attapulgus Clay Co.

7—Catalyst Tube Cleaner

The job of removing spent catalyst material from tubular catalyst reactors is said to be accomplished conveniently and economically by the use of the "Lagonda" catalyst tube cleaner unit, which makes the operation a one-man job, handled from the top of the reactor. The equipment weighs 30 lbs., can be shifted easily from tube to tube. It utilizes a standard air-driven motor, and has enough clearance in the tube to permit loosened catalyst to be blown by exhaust air out through a discharge elbow. A sponge rubber gasket seals the tube end. Elliott Co.

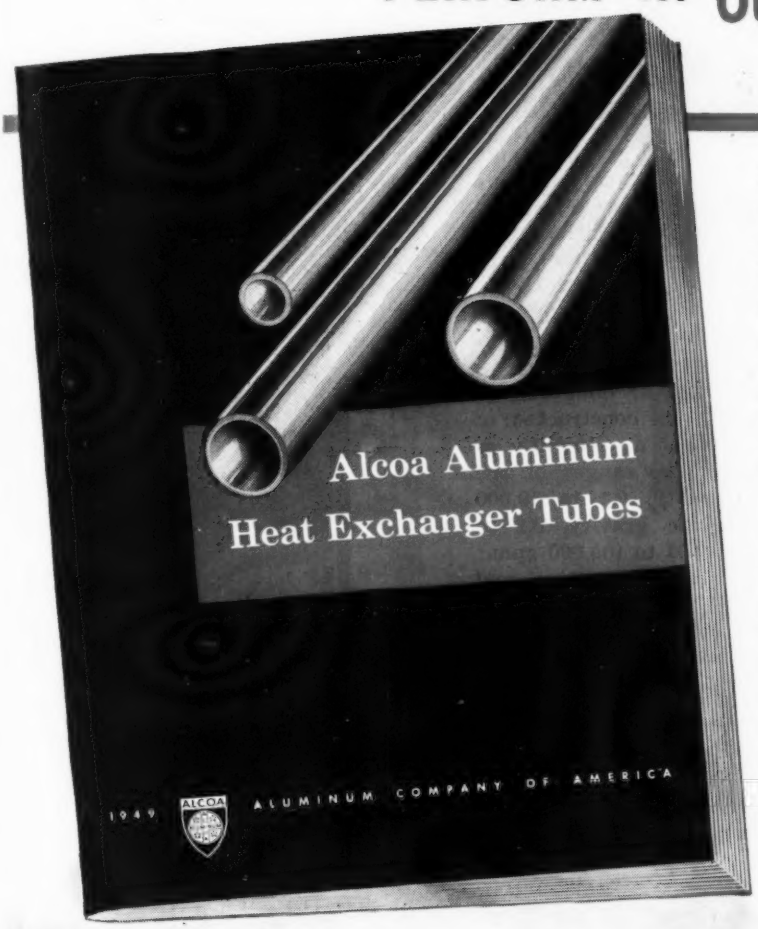
8—Gage Glass Guard



The No. 28 "Kleervu" gage glass protector has been approved by the California State Dept. of Labor as a safety guard for the protection of both employees and equipment against the possibility of injury from flying glass or the escape of harmful fluids when a gage glass bursts. It completely encloses the gage glass and consists of a metal guard at the back and a "Nuglas" plastic transparent protector at the front. It will fit any gage on which the dimension of the packing nut does not exceed 1⅞ in. across the hexagon. The unit can be furnished in sizes ranging from 4 in. to 8 ft. in height, permitting its use on large processing tanks as well as on conventional boiler gages. Wright-Austin Co.

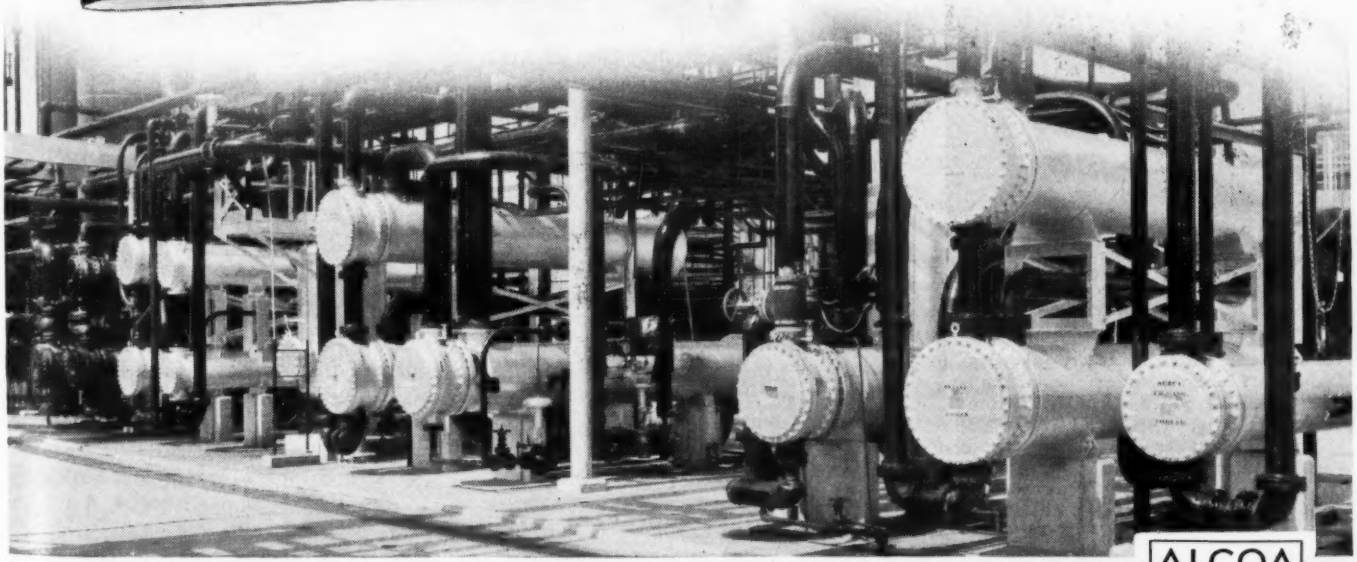
More "What's New!" Items, p. 316

LOW COST ALCOA HEAT EXCHANGER TUBES PERFORM IN Sub Zero Temperatures



Liquefied gases take the fight out of most metals. This book tells how they toughen and strengthen Alcoa Aluminum Heat Exchanger Tubes. Aluminum tubes frequently last more than 15 years in refinery service. These properties make them your logical choice for tonnage oxygen, gas liquefaction, propane extraction, dewaxing and any other processes involving low temperatures.

Alcoa Exchanger Tubes pack all these advantages at a cost approximately ½ of Admiralty, ⅔ of cold drawn seamless steel, ⅙ of stainless or monel. The complete story is in the booklet, "Alcoa Aluminum Heat Exchanger Tubes". Ask your nearby Alcoa sales office for a free copy. Or write ALUMINUM COMPANY OF AMERICA, 697 Gulf Building, Pittsburgh 19, Pennsylvania.



ALCOA ALUMINUM
HEAT EXCHANGER TUBES

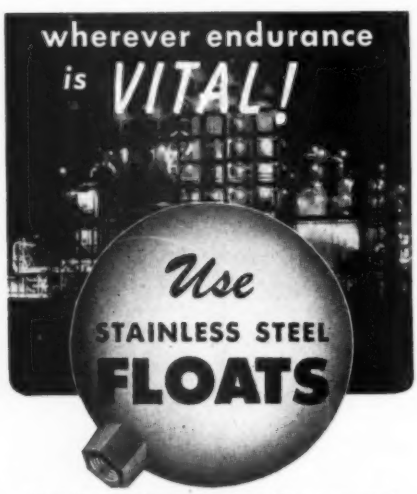
ALCOA
ALUMINUM

Building

- **FOR THE PETROLEUM INDUSTRY**
- We are fully staffed to design, build, and equip complete refineries and chemical processing plants.
- Under one contract and one responsibility, we deliver each job complete . . . ready for operation.
- We also furnish engineering reports and surveys. Current cost data available at all offices.

The H.K. Ferguson Co.
INDUSTRIAL ENGINEERS AND BUILDERS

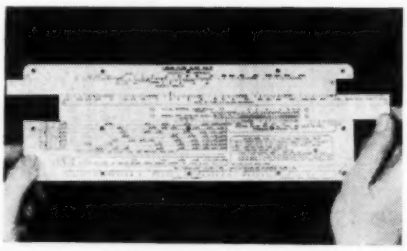
THE FERGUSON BUILDING • CLEVELAND, OHIO
OFFICES IN NEW YORK, HOUSTON, CHICAGO, CINCINNATI AND LOS ANGELES



For the severe services that are part of modern petroleum processing, you can't make a better choice than STAINLESS STEEL FLOATS from Chicago Float Works. STAINLESS FLOATS give you longer life and less maintenance trouble under temperatures to 800°F. and pressures to 1000 lbs...send for catalog with information on complete line of standard sizes, shapes, and spud connections. Special sizes, shapes made to order. MONEL METAL floats also available for specialized applications.

CHICAGO FLOAT WORKS, INC.
2328 S. Western Ave.
Chicago 8, Illinois

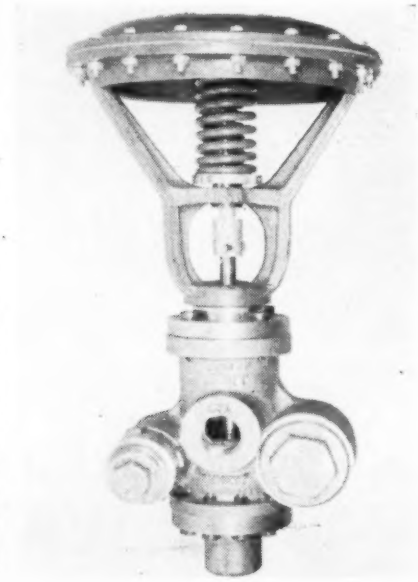
9—Liquid Flow Slide Rule



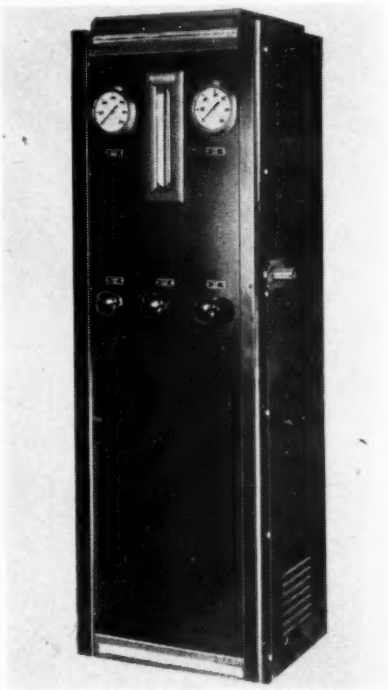
Designed to aid in solving problems in the flow of liquids through pipe, the new Liquid Flow Slide Rule is said to solve the rational fluid flow formula known as the Fanning or Darcy equation, in a fraction of the time required by usual methods. Among calculations which can be performed are: 1) pressure drop, 2) carrying capacity, and 3) diameter required. The rule is constructed of white and transparent Vinylite, is 10½ x 3¾ in. The ranges of the scales are: viscosity, 0.1 to 10,000 centipoises; specific gravity, 0.2 to 20; rate of flow, 0.01 to 100,000 gpm.; pipe size, ¼ to 24-in. nominal, and 0.3 to 25 in. actual internal diameter. It will indicate automatically whether turbulent or streamline flow exists in a given problem. Coleman J. Major.

10—High Pressure Valve

The new "Merit" line of diaphragm-actuated, two-pressure valves is designed for a wide range of application in high pressure hydraulic service. The valves range in size from 1 to 4 in., and can be furnished for operation on systems having 3000, 5000, and 10,000 psi. pressures. Variations of assembly provide for: 1) diaphragm - controlled high - pressure inlet; 2) diaphragm-controlled slow-travel, or 3) diaphragm-controlled stop valve, all within one casting. Seat rings can be reversed and the need for gaskets as pressure seals on cap ends is avoided. Emmett Machine and Mfg. Inc.

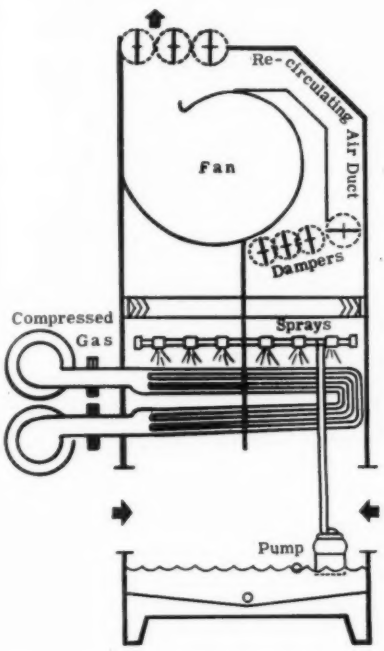


11—Chlorine Dispenser



Complete safeguards are said to be features of the new "Rato-Chlor" Chlorine Dispenser. The unit is a "dry vacuum" type, using no water seals, bell jars, poppets, or similar devices commonly associated with chlorinators. Chlorine from the cylinder, drum, or tank car is filtered first to remove gum-forming hydrocarbon impurities, and is then delivered to the Rato-Chlor at a controlled pressure of —20 in., water column. Flow rate is adjusted by a packless, needle-type regulating valve and is measured by a "Flowrator" calibrated in lbs./day of chlorine vapor. A differential pressure regulating valve maintains the preset flow rate constant. A vacuum-operated shutoff valve automatically interrupts the flow in the event of any leakage in the dispenser. Chlorine flow is also stopped automatically if the ejector supply water is shut off. The instrument can be equipped with recording or totalizing accessories or it can be tied in with flow transmitters to automatically proportion chlorine flow to main line flow variations. The dispensers are produced in 17 standard sizes ranging from 10 to 7500 lbs./day. Fischer & Porter

12—Air or Gas Dryer



Protection from freezing in outdoor installations is said to be a feature of the Niagara "Aero After Cooler", which dehydrates compressed air or gas by cooling it to below the dry bulb atmospheric temperature, thereby removing condensed moisture and preventing further condensation in air or gas lines in service. Cooling is accomplished by evaporating a recirculating water spray on the surface of a coil through which the compressed air or gas passes, creating a temperature close to the wet bulb temperature of the surrounding atmosphere and lower than dry bulb temperature and lower than the summer surface water temperature. Protection against freezing is given by use of a so-called "Balanced Wet Bulb" control. A thermostat in the spray water reservoir is set for a desired low temperature limit, at which it operates dampers to recirculate the air stream internally around a division plate in the center of the unit, instead of drawing in freezing external air. Niagara Blower Co.

13—"Bis" Benzene

The chemical and physical properties of bis (trifluoromethyl) benzene suggest its use as an intermediate in the peparation of non-flammable dielectric and hyraulic fluids and as a starting material for preparing dyestuffs. The material is a mixture of the para and meta isomers. It has a specific gravity at 20° C. of 1.395, a freezing range of —40 to — 50° C., a distillation range of 113 to 117° C., and a flash point of 37° C. Pilot plant production is now under way at the Niagara Falls, N. Y., plant of Hooker Electrochemical Co.

Trade Literature

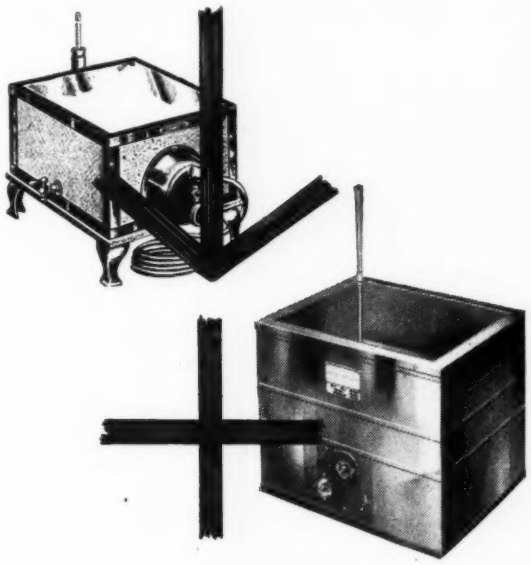
14—Pressure Transmitters

Differential-Pressure Transmitters, Bulletin 102; 8-page booklet giving schematic diagram and explaining principle of operation, including dimensions, specifications, and a table of transmitted pressure ranges of the instrument. Moore Products Co.

15—Chemicals

Mathieson Chemicals, a new 32-page booklet presenting a complete description of a line of caustic soda, soda ash, bicarbonate of soda, liquid chlorine, ammonia, hypochlorite products, and many others. Mathieson Chemical Corp.

More "What's New!" Items, p. 318



The direction of plus-

A summary of achievement

Even the manufacture of a simple water bath—when engineered by Precision—indicates the direction of plus... the constant, never ceasing, striving for the very best.

The bath of modern design above is improved internally as well as in appearance. For example, it has a hydraulic thermostat with adjustable dial control which can be set to operate the bath at any point from room temperature to 100°C.

The illustrations indicate the changes incorporated in construction—simplicity of design considering every demand of the modern laboratory; operating flexibility where one model is now capable of doing double and even triple duty merely by using interchangeable covers, and; polished stainless steel throughout. Truly an example of the endless chase in the direction of plus.

Precision Scientific Company

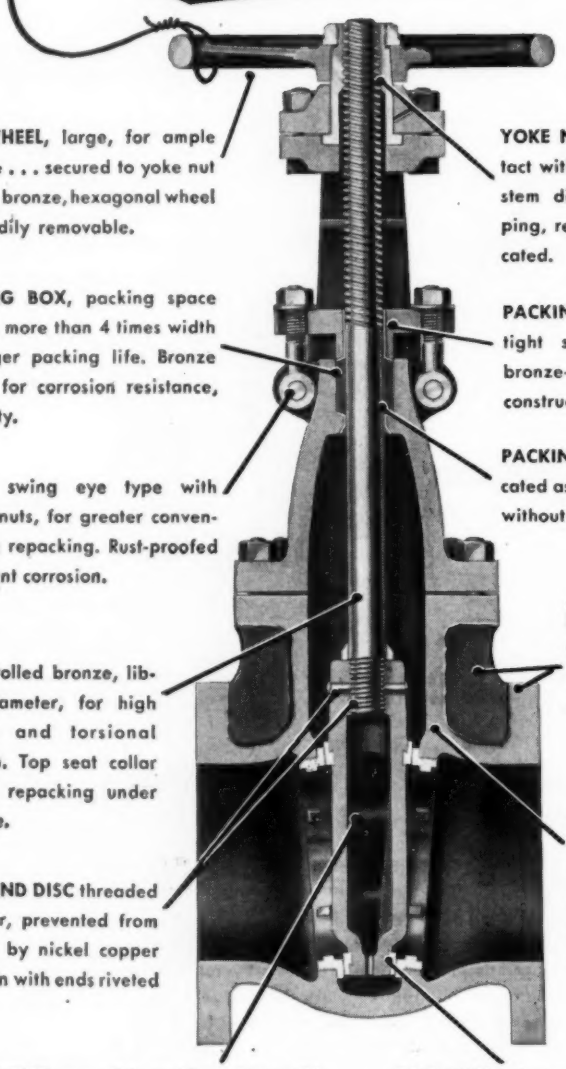
3737 West Cortland Street • Chicago 47, Illinois

BRANCH OFFICES in New York, Philadelphia, San Francisco

DEALERS IN ALL PRINCIPAL CITIES

Precision Engineering Makes this KENNEDY VALVE Rugged and Dependable...

KENNEDY STANDARD IRON BODY WEDGE GATE VALVE Fig. 0611, outside-screw-and-yoke. Service up to 125 lb. p.s.i. steam; 200 lb. p.s.i. water, oil or gas. 1½" through 48" sizes available.



HANDWHEEL, large, for ample leverage . . . secured to yoke nut by large bronze, hexagonal wheel nut, readily removable.

STUFFING BOX, packing space depth is more than 4 times width for longer packing life. Bronze bushed for corrosion resistance, durability.

BOLTS, swing eye type with washer nuts, for greater convenience in repacking. Rust-proofed to prevent corrosion.

STEM, rolled bronze, liberal diameter, for high tensile and torsional strength. Top seat collar permits repacking under pressure.

STEM AND DISC threaded together, prevented from turning by nickel copper alloy pin with ends riveted over.

YOKE NUT, bronze, thread contact with stem at least 1½ times stem diameter eliminates stripping, reduces wear, easily lubricated.

PACKING GLAND machined for tight seal with stuffing box, bronze-bushed at stem. Slotted construction simplifies repacking.

PACKING, molded rings of lubricated asbestos maintain tightness without excessive gland pressure.

FLANGES are heavy and well filleted. Flanged ends have reinforcing ribs for extra strength.

BODY AND BONNET, Kennedy Higher Strength Cast Iron, generous metal thicknesses and well rounded corners provide maximum strength.

WEDGE DISC, reversible and interchangeable, reinforced by integrally cast interior posts. Openings permit drainage in any position.

DISC RINGS, bronze, wide and thick, forced into dove-tailed grooves in disc to form practically integral construction.

Write for Bulletin No. 50. BUY FROM YOUR LOCAL DISTRIBUTOR

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VALVES • PIPE FITTINGS • FIRE HYDRANTS

OFFICE-WAREHOUSES IN NEW YORK, CHICAGO, SAN FRANCISCO • SALES REPRESENTATIVES IN PRINCIPAL CITIES

What's New!

16—Steel Tubing Data

Babcock & Wilcox Tube Co. now has available the latest edition of five tables useful to engineers who deal with steel tubing. Included are the following data cards: No. 115, *Tolerances of Round Seamless Steel Mechanical Tubing;* No. 112, *Metric Conversion Table;* No. 110, *Linear Conversion Table;* No. 103, *Wall Thickness Data for Seamless and Welded Tubing;* and No. 125, *Hardness Conversion Tables.* Babcock & Wilcox Tube Co.

17—Foreign Refining

Kelloggram, Issue No. 1, Series 1949, is devoted to an article on global conditions in oil refining, analyzing the various processing techniques country by country, and giving a reassuring picture as regards the issue of petroleum shortages. M. W. Kellogg Co.

18—Low Temperature Insulation

Zerolite Insulation, a four-page folder giving properties and describing a fire-resistant insulation in sheets and in pipe covering shapes, for refrigeration service in such applications as dewaxing equipment, gas purifiers and condensers, chillers and exchangers, solvent storage and piping, ammonia lines, brine coolers, and the like. Material has temperature limits of —400 to +250° F. Johns-Manville.

19—High-vacuum Apparatus

High Vacuum Apparatus, Bulletin 10; 48 pages on laboratory equipment useful in high vacuum studies, including explanatory details on how to plan a vacuum system, along with engineering data on pumps, connections, etc. Central Scientific Co.

20—Petroleum Processing Index

Petroleum Processing Index for 1948; covers all special articles and stories as well as all regular departmental features for the 12 issues of the past year. Classification by subject and by author, completely cross-referenced for ease of use. National Petroleum Publishing Co.

21—Column Grid Trays

Kerlow Grid Trays for the Petroleum, Chemical, and Process Industries, Catalog G-48; gives standard patterns, and specifications on a line of grid trays for fractionating columns, extractors, and other processing equipment. Kerlow Steel Flooring Co.

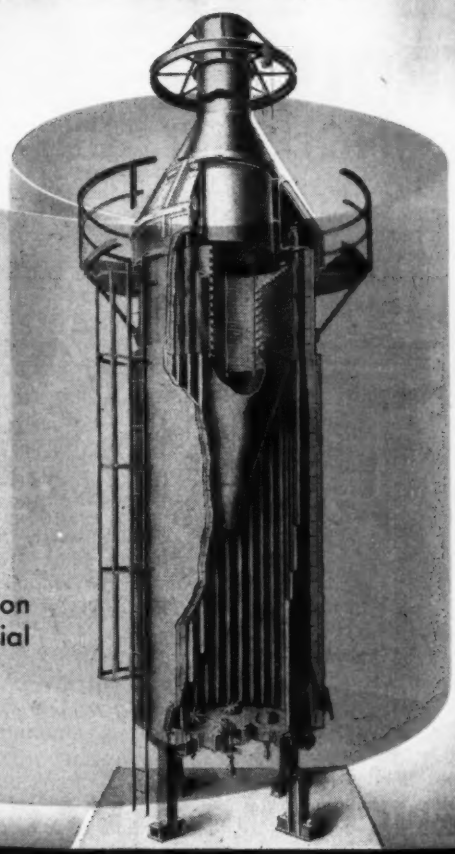
More "What's New!" Items, p. 320

Petro-Chem Iso-Flow Furnaces

Pre-Eminent

For Multi-Pass Operation . . . .

Uniform heat distribution per pass being a most important essential to efficient operation of multi-pass furnaces, it is significant that Petro-Chem Iso-Flow Furnaces are unequaled for uniform heat distribution per pass because their cylindrical design and vertical tubes provide a perfectly symmetrical pattern on the fluid and combustion sides, regardless of the number of passes required.



Each bank of tubes (each pass) is equi-distant from the flame.

●

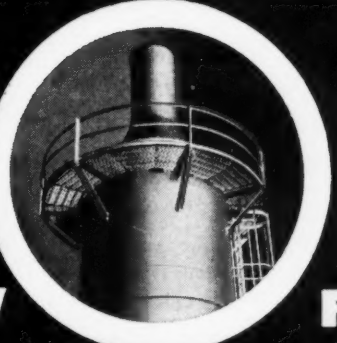
Each bank of tubes (each pass) is exposed to the same heat intensity.

●

Length of fluid travel for each pass (including crossovers) is identical from inlet to outlet.

●

All of the above give the minimum variation in tube wall temperature and are essential for critical high temperature operation.



PETRO CHEM

ISO-FLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INCORPORATED

120 EAST 41ST STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply Co., Tulsa and Houston • Lester Oberholtz, Calif. • D. D. Foster Co., Pittsburgh • Faville-Levally Corp., Chicago

22—Steam Trap Problems

Solving Steam Trap Problems, a 36-page booklet telling how steam traps are selected, used, and maintained; including recommended sizes, and helpful engineering graphs and tables. V. D. Anderson Co.

23—De-scaling Exchanger Tubes

The Mechanical Cleaning of Fouled Heat Exchanger Tubes, a reprint of a paper given at the recent annual meeting of the American Society of Mechanical Engineers by Mr. A. John, assistant general manager, Thomas C. Wilson, Inc.

24—Instrument Catalog

Speedomax, Type G Instruments, Catalog ND46(1); 44 pages describing complete line of indicators, indicating recorders, and recording controllers, both electric and pneumatic types. Leeds & Northrup Co.

25—Welding Fittings

Globe Precision Process Welding Fittings, Catalog No. 501; in ring-binder, looseleaf style for easy reference and additions, covering line of seamless steel welding fittings, and including specifications and prices for 45 and 90° elbows and return bends in pipe sizes from 1 to 12 in. Globe Steel Tubes Co.

26—Heat Exchangers

Karbate Heat Exchangers; 8-page bulletin on a line of heat exchange equipment made of "Karbate" and useful because of resistance to a large number of acids, salt solutions, alkalies, organic compounds, etc. Foster Wheeler Corp.

27—Oil and Gas Equipment

BS&B Condensed General Catalog, Jan., 1949; 54 pages giving complete information on separators, treaters, heaters, tanks, valves, fittings, walkways, loading racks, safety heads, vent valves, oil meters, etc. Black, Sivalls & Bryson, Inc.

28—Stainless Electrodes

Lincoln Weldirectory for Stainless Steel, Bulletin 463; 8 pages, perforated for easy filing, listing a line of stainless steel electrodes, giving application, properties of deposited metal, and proper welding procedures; illustrated. Lincoln Electric Co.

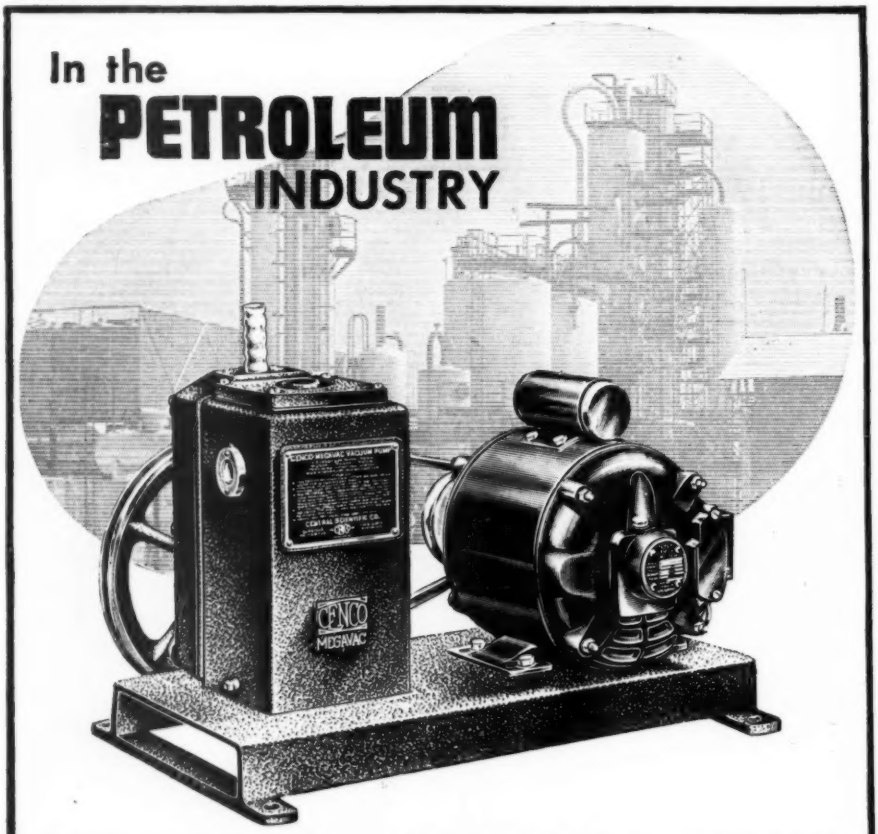
29—Liquid Level Gages

Liquid Level Gage, Bulletin A-120.0; describes a new "Trulevel" Gage, Model A, for distance reading of water level; using an inverted U-tube manometer and electric illumination; in two sizes; for pressures below and above 900 psi. Jerguson Gage & Valve Co.

Correction

Item 9, "What's New!" February, 1949, p. 195; reporting that research quantities of "hexadecane" are available now from Houdry Process Corp. The correct spelling of the chemical is "hexadecene."

In the **PETROLEUM INDUSTRY**



THE CENCO MEGAVAC PUMP

combines in a single mechanical unit high ultimate vacuum with high pumping speeds for fractional distillations, temperature and pressure measurements and other laboratory or pilot plant procedure which requires fast initial evacuation. This unit is proved for dependable and trouble-free service. Speed at 1 micron, 375 ml; vacuum, 0.1 micron or better.

Specify No. 92015A Cenco Megavac Pump mounted with base and motor for 115 volt, 60 cycle AC operation . $198.00

(Also available with motors for other voltages and frequencies.)

SERVING SCIENCE CENCO

Write Dept. B. E. for engineering Bulletin 10 "High Vacuum Equipment".

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For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 312. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

NEWS OF

Manufacturers—Suppliers—Engineering Firms

Serving the Petroleum Processing Industry

Personnel Changes

Hooker Electrochemical Co.—H. M. Hooker has announced his resignation as chairman of the board of directors. He will continue as a member of the Board. Other organizational changes include: R. L. Murray, from vice president in charge of development and research to executive vice president; R. W. Hooker, from vice president and sales manager to vice president in charge of sales; J. H. Babcock, from manager of development and research to director in full charge of activities of that department; R. E. Wilkin, from eastern sales manager to general sales manager.

T. L. Lyster, chief engineer from 1914 to 1917 and from 1937 through 1948, has retired, but will continue as consulting engineer. E. K. Newton, with Hooker since 1910, has been appointed chief engineer.

Marlow Pumps—Andre S. Rubin, Jr., has been appointed sales manager, with headquarters at Ridgewood, N. J. With Marlow since 1942, Mr. Rubin was previously associated with Continental Oil Co., from 1934, when he was graduated from Rensselaer Polytechnic Institute, until 1942.

Fluor Corp. — New officers for 1949: Shirley E. Meserve, general counsel since 1929 and president since 1947, was elected chairman of the board. Donald W. Darnell, who joined the company in 1925 as an engineer, moved up from vice president. and general manager to Mr. Meserve's position as president. J. S. Fluor, Jr., away from Fluor since 1946, returned as executive vice president. W. Earl Dunn, formerly executive vice president, was named vice president and general manager of the new engineering and construction division; and J. Robert Fluor, formerly vice president and assistant general manager, was appointed vice president and general manager of the manufacturing division.

Allegheny Ludlum Steel Corp.—C. A. Scharschu, formerly director of research, has been named assistant technical director. Dr. L. C. Hicks, associate director of research, will fill Mr. Scharschu's former position.

Taylor Forge & Pipe Works—R. W. (Pat) Murphy has been designated advertising manager, with headquarters at the company's general offices in Chicago, Ill.

Lukens Steel Co.—Robert W. Moffett, general manager of fabrication, has announced his retirement from active participation in company activities. Raymond M. Dennis, formerly assistant to the general manager of fabrication at By-Products Division, has been named manager of fabrication; and Frank C. Kardevan, formerly assistant to the general manager of fabrication of Lukenweld Division, has been appointed manager of fabrication for that division.

American Steel & Wire Co.—William I. Ong has been named assistant to the president. Mr. Ong has directed the company's public relations department since its organization in 1937, and the Ohio-Michigan district public relations activity of other United States Steel subsidiaries as well. Prior to 1937, he was associated for 10 years with Dow-Jones & Co., publishers of the *Wall Street Journal.*

Spencer Chemical Co. — Howard Millington, until recently in the market research department, has been appointed chemical sales representative in the area comprising Chicago, Milwaukee, Minneapolis, St. Paul, Detroit, Cincinnati, and Cleveland. He will maintain offices at 208 S. La Salle St., Chicago, and will cover primarily sales in ammonia, methanol, and formaldehyde.

Black, Sivalls & Bryson, Inc.—Gen. Harlan L. Mumma, U. S. A. Ret., has been named world export manager with headquarters at 30 Rockefeller Plaza, New York City. He will be concerned with the distribution of propane tanks for the LPG industry in South America as well as specially designed storage vessels for chemical and other industries in that area. Earl Ruth, formerly sales engineer in the Kansas City executive offices, will join Gen. Mumma's staff.

Branches, Distributors

Alloy Steel Products Co. has opened a New York sales office with Richard E. Boller, Jr., as district manager. Associated with Mr. Boller will be Ralph O. Dale, Henry G. Harley, and Elliot A. Baines as sales representatives. The office will serve the Metropolitan Area including New York State and New England.

Foxboro Co. has opened three new branch offices and established resident engineers in two more cities. Milton A. Schreiner with the company since 1922, will be manager of the new office at 123 West College Ave., Appleton, Wis. George J. Willier, with Foxboro since 1944, heads up the branch at 6225 Brookside Ave., Kansas City 2, Mo. At Baton Rouge, La., John B. Deaderick is manager of the office recently opened at 115 North 19th St.

The new resident engineers are Eugene F. Machell, at 209 North 79th St., Milwaukee 13, Wis. and Russell E. Steward, at Frankfort, N. Y., serving the Utica area.

Kuljian Corp., engineers and constructors of Philadelphia, have announced the appointment of Edwin Lundgren as Washington representative, with offices at 1415 K Street, N. W.

Tube Turns, Inc., has named **Ardun Co.** as a Tulsa distributor of Tube-Turn welding fittings and flanges. The firm, with offices and warehouse at 317 South Detroit Ave., Tulsa, is a new partnership formed by H. W. (Doc) Arduser and Robert H. Duenner, Jr.

Peerless Pump Div., Food Machinery and Chemical Corp. has appointed J. W. L. Stone as district manager of a newly formed Peerless sales district with headquarters located at 4330 Leavenworth St., Omaha, Neb. Mr. Stone was formerly a field engineer for Peerless in the southwest. His territory will include North and South Dakota, Montana, Minnesota, Nebraska, Kansas, Colorado, and portions of Wyoming, Missouri, Wisconsin, and Iowa.

Expansion, Transition

Mason-Neilan Regulator Co. has developed a novel "Field Demonstrator" designed to bring the "Masoneilan" line of control valves and industrial instruments to plant operating personnel in the petroleum and other chemical processing industries.

Mounted in the body of a large panel-type truck, and at the rear end, the demonstrator is constructed with two side panels which swing out to a right-angle position which, together with the rear section itself, forms a display about 20 ft. wide. A compressor is included as auxiliary equip-

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IN AN attempt to increase the production capacity of his processing units, a Texas operator tried cleaning his equipment with live steam and hot water. This method proved ineffectual . . . costly. The Oakite Technical Service Representative was called in. He studied temperatures, pressures, deposits. He recommended a specially designed Oakite cleaner for quick, easy circulation through the *entire* system . . . absorber, heat exchanger, still, pre-heater.

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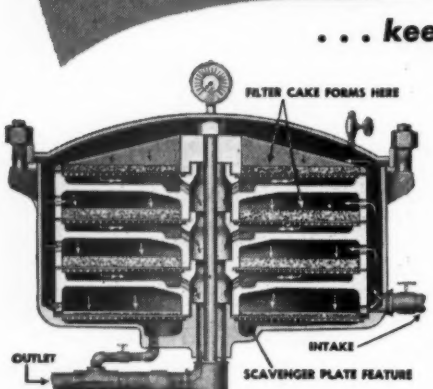

The Sparkler horizontal plate method of filtration insures a firm, unbroken filter cake formed from diatomaceous earth or other filter media particularly suited to the liquid filtered. Such a filter cake removes even microscopic particles from any liquid ranging from light alcohols to heavy resin products.

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Sparkler filters are available in capacities from small pilot plant models to built-in production line units of 5000 gallons per hour. The services of our staff of engineers with over a quarter of a century experience in solving filtration problems is available. Your problems will receive personal attention and individual analysis. Write Mr. W. J. Kracklauer, Sec'y & Treas.

SPARKLER MANUFACTURING COMPANY, Mundelein, Illinois

Expansion

ment for supplying air for operation of some of the products, which include valve positioners, liquid level controllers, pneumatic pressure switches and pressure regulating valves.

Foxboro Co. has begun work on an addition to their branch office building at 5151 Baum Blvd., Pittsburgh. To be ready for occupancy in early spring, the new addition will be used for assembly of control valves and for warehousing an increased stock of valves and instruments. A. H. Shafer, with Foxboro since 1921 and district manager in Pittsburgh area since 1930, is in charge.

Republic Supply Co. of California have announced the official opening of a new $1,250,000 home office and warehouse on a 14-acre site, one block south of East Washington Blvd., at the corner of Eastland and Sheila Sts. The one-story warehouse building totals 90,000 sq. ft. with an additional 23,000 sq. ft. of pipe storage area. Six acres of the property have been set aside for future expansion.

Mine Safety Appliances Co. has started construction of a modern four-story, research laboratory with completion scheduled for September, 1949. The building will be located one block from the company's Pittsburgh plant, and will be known as the John T. Ryan Memorial Laboratory, in honor of one of the founders of MSA. Dr. William P. Yant, director of research and development since 1936, will be in charge of activities.

MEETINGS . . . for the Oil Man

MARCH

27-Apr. 1, American Chemical Society, 115th National Meeting (headquarters for Division of Petroleum Chemistry, Mark Hopkins Hotel), San Francisco.

28-30, Western Petroleum Refiners Assn., Plaza Hotel, San Antonio, Texas.

APRIL

4-7, American Petroleum Institute, Division of Refining, Shamrock Hotel, Houston.

11-13, American Society of Lubrication Engineers, Hotel Statler, New York.

11-12, American Institute of Electrical Engineers, Conference on the Industrial Use of Electron Tubes, Statler Hotel, Buffalo, N. Y.

11-14, National Assn. of Corrosion Engineers, 5th Annual Conference and Exhibition, Netherlands-Plaza Hotel, Cincinnati, Ohio.

13-15, National Petroleum Assn., Hotel Cleveland, Cleveland.

20-22, Natural Gasoline Assn. of America, Texas Hotel, Ft. Worth, Texas.

MAY

9-11, Liquefied Petroleum Gas Assn., Meeting and Trade Show, Palmer House, Chicago.

12-13, Instrument Society of America, 4th Annual Spring Meeting, Royal York Hotel, Toronto, Canada.

JUNE

5-10, Society of Automotive Engineers, Summer Meeting, French Lick Springs Hotel, French Lick, Ind.

9, Chemical Market Research Assn., Annual Business Meeting, Biltmore Hotel, New York.

27-July 1, American Society for Testing Materials, 52nd Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

Personals

M. D. Gjerde, manager, Sales Technical Service Department, Standard Oil Co. (Indiana), is chairman of the Fuels and Lubricants Committee of the Society of Automotive Engineers. He succeeds **E. W. Upham,** chief metallurgist, Chrysler Corp., who resigned after 20 years of service in this work.

Mr. Gjerde

A graduate of Purdue University in mechanical engineering, Mr. Gjerde joined the Indiana Standard in 1923 and engaged in lubrication engineering and sales work. In 1928 he came to Chicago, later becoming head of the Automotive Division of the Sales Technical Service Department. Since 1937 he has been manager of that department.

* * *

J. R. Bailey is assistant manager of the natural gasoline and gas division of Continental Oil Co., Ponca City, Okla. He studied petroleum engineering in Colorado School of Mines and joined Continental in 1940 as district engineer in the natural gasoline and gas division at Basile, La. He came to Ponca City as division engineer in 1942 and was promoted to superintendent of development in 1947.

F. B. Willson succeeds Mr. Bailey as superintendent of development, natural gasoline and gas division, Continental Oil Co. He attended the University of Michigan and received a B.S. degree at University of Colorado in 1924. He joined Continental in 1936 at Lance Creek, Wyo., and became assistant process engineer at Ponca City in 1943, and in 1946 was made assistant to the manager of the natural gasoline and gas division.

J. M. Cook is the new chief clerk of the division. He studied mechanical engineering at University of Arkansas and at Arkansas Polytechnical College and started to work for Continental in 1936 at Wichita Falls, Texas, as a production clerk, and was transferred to Ponca City in 1941.

* * *

E. R. Wagner has been named plant superintendent of Stanolind Oil and Gas Co.'s new Slaughter natural gasoline plant near Levelland, Texas, expected to be completed next March.

Mr. Wagner goes to the Slaughter plant from Stanolind's Salt Creek gasoline plant at Midwest, Wyo., where he has been plant superintendent since July, 1943. He studied at South Dakota School of Mines and the University of Wyoming, joining the company in 1933.

* * *

E. G. Dahlgren has resigned as assistant secretary of the Interstate Oil Compact Commission to become an oil and gas consultant with offices at Oklahoma City. After serving with PAW during the early part of the war he became technical secretary of the Research and Coordinating Committee of the Commission, later, assistant secretary in charge of technical activities.

Mr. Dahlgren

Julian Alexander, Jr., has joined the staff of the American Petroleum Institute, where he is associated with William T. Gunn, the director of the Refining Division. A graduate of the University of Pennsylvania in 1938 with a bachelor's degree in physics, he had been for 10 years with the Houdry Process Corp., Marcus Hook, Pa. The last six years he was manager of the Houdry analytical and testing laboratories.

Mr. Alexander

* * *

A. C. Atwater is manager of the petroleum and chemical division of Thomas Bryan & Associates, Houston. He formerly was with Arthur G. McKee & Co., Cleveland, connected with refinery construction assignments in the U.S. and abroad.

* * *

Lynn R. Strawn is manager of the Neches plant of Jefferson Chemical Co. He holds a B.S. in chemical engineering from Denver University and an M. S. from Columbia and started with The Texas Co. in 1932 at Port Arthur, where he has recent-

Indiana Standard Scientists Have Own Club

Marvin DenHerder, secretary-treasurer of the Whiting Science Club; Philip Hill, president; Howard Parker vice-president

Chemists and engineers of the Standard Oil Co. (Indiana) have formed a new organization, the Whiting Science Club, designed to broaden the technical background of its 350 members.

At dinner meetings five times a year, scientists from the laboratories and refinery at Whiting and the general offices in Chicago are addressed by authorities in various scientific fields. Among their speakers have been Dr. Ernest H. Volwiler, president-elect of the American Chemical Society, and Dr. Enrico Fermi, Nobel prize winner in physics. The club also sponsors lecture courses in petroleum technology.

Philip Hill is president of the Whiting Science Club, Howard Parker is vice president and Marvin DenHerder secretary-treasurer.

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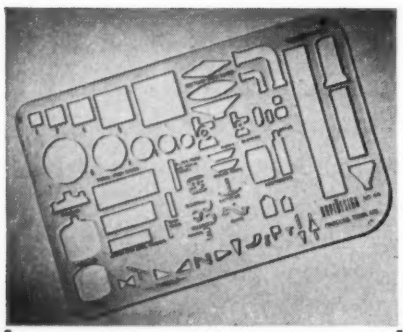

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P. O. BOX 592, GLENDALE, CALIF.

ly been in charge of process engineering in all phases of light oil and lubricating oil manufacture and gas processing.

A. A. Triska, previously manager of the Neches plant of Jefferson Chemical Co., has been transferred to New York, where he will be assistant to the manager of the production department.

* * *

D. R. Johnson is manager of Continental Oil Co.'s manufacturing department, with supervision over its 8 refineries. Graduating in electrical engineering from the University of Colorado he joined the company in 1924 as an electrician at the Glenrock, Wyo., refinery. He went to Ponca City in 1929 as a technologist and later became superintendent of the Ponca City refinery. In 1948 he was made southern region manager.

Mr. Johnson

L. W. Vickery succeeds Mr. Johnson as manager of the southern region of the manufacturing department of Continental Oil. He received degrees from Southwestern College, Winfield, Mass., and from Massachusetts Institute of Technology. He joined Continental as a refinery draftsman in 1929 and later became superintendent of the Ponca City plant.

Charles D. Hull is the new superintendent of the Ponca City refinery. He attended college at Springfield, Mo., and joined the company in 1919. He served in the accounting and administrative divisions of the manufacturing department and was made assistant to the vice president in 1928.

C. B. Round is assistant to the vice president of Continental Oil. He graduated from the University of Oklahoma and started with the company as a clerk in 1929.

* * *

Mr. Post

John Post is manager of Continental Oil Co.'s new industrial relations department. A law graduate of Columbia University, he was associated with Allied Chemical and Dye Corp., and with a New York law firm and more recently was manager of the employee relations department of Standard Brands, Inc., New York.

Gilmore T. Gwin is president for 1949 of the Society of Professional Chemists and Engineers of Baytown, Texas (Humble Oil & Refining Co.) A native Texan, he received a degree in chemistry from Rice Institute in 1934, joined Humble, and at present is engaged in catalytic cracking research in the Technical and Research Division.

Mr. Gwin

Mr. Greaney

Thomas J. Greaney is vice president of the Society. He is also a native of Texas and graduated from Rice Institute in Chemical Engineering in 1943, joining Humble shortly thereafter. He is currently specializing in economic analysis in the Technical and Research Division.

Thomas M. Babin is secretary of the Society. He received a degree in civil engineering from Louisiana State University in 1942. He is currently employed in the Maintenance Engineering and Inspection Division of the Humble plant at Baytown.

Mr. Babin

Mr. Schweitzer

William H. Schweitzer comes from New Mexico and graduated in civil engineering from Texas Tech in 1943. He has been with Humble since except for two years active duty with the Navy and is at present in the Mechanical Engineering Division.

The Society of Professional Chemists and Engineers is the only economic purpose organization of professional men in Texas, its membership being limited to non-supervisory chemists, engineers and physicists with one year of service or more in the Humble Baytown refinery. Its present membership of 184 is said to include 90% of the eligible professionals.

There are two other such organ-

izations in the petroleum industry, the Research and Engineering Professional Employees Assn. at Whiting, Ind. (Standard Oil Co. of Indiana) and the Association of Industrial Scientists at Emeryville, Cal. (Shell Development Co.). To expedite the exchange of ideas and information the three groups have formed the HIS (Humble-Indiana-Shell) Conference.

* * *

George T. Tennison is manager of the newly created Regional Gas Department of Shell Oil Co., to coordinate the gas activities of Shell's four areas east of the Rockies. He joined the company in 1937 as gas contract representative at Tulsa. He was later transferred

Mr. Tennison

Mr. Church

Mr. Jordan

to Houston and in 1946 became assistant to the regional director of the Gas-Gasoline Department.

Merle R. Church is head of the Gas Engineering Section of the Engineering Division of Shell's Regional Production Department, and will deal with the construction of gasoline and cycling plants. A graduate of Oklahoma A. & M. College, he joined Shell in 1925, served as superintendent of two gasoline plants and in 1947 became assistant to the Houston Regional Director of the Gas-Gasoline Department.

John T. Jordan is head of the Technological Section of the Engineering Division of Shell's Regional Production Department. A graduate of Oklahoma University, he joined the company in 1936 and in 1940 was transferred to Houston, later being promoted to Chief Technologist of the Regional Gas-Gasoline Department.

* * *

Col. J. F. Drake, board chairman, Gulf Oil Corp., has received the Award of Chevalier of the French Legion of Honor in recognition of services rendered to France.

H. J. Holcomb of the process engineering department of the Augusta, Kans., refinery of Socony-Vacuum Oil Co., Inc., has been transferred to the pipeline department in New York.

* * *

Roland Vokac is associated with the Husky Refining Co., Cody, Wyo., in a consulting and advisory capacity and will assist in the development of the company's industrial asphalts. For a number of years he was with the Berry Asphalt Co., Chicago, in a research capacity.

James O. Clayton, research associate of California Research Corp. (Standard Oil Co. of California), is chairman of the Pacific Chemical Exposition, scheduled for Nov. 1-5, at San Francisco civic auditorium. Assisting him on the Exposition Committee are **Lloyd F. Brooke** and **Dorr H. Etzler,** California Research Corp.; **L. W. Van Doren,** Oronite Chemical Co., and **Worden Waring,** Shell Development Co., among others. The California Section of the American Chemical Society is sponsoring the Exposition.

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Natasco Corrosion Prevention Service for storage tanks keeps new tanks new and makes old ones give additional years of service. Scientific preparation of all surfaces and application is performed by experienced Natasco Crews.

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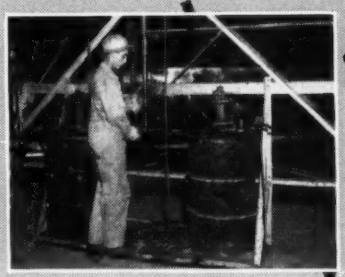

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The Natasco Line of laboratory-perfected and field-tested products consists of eighteen products each having a specific application to corrosion problems and conditions. The use of the one — singly or in combination — is dependent upon the conditions in the area or the extent of corrosion on the tanks.

CALL NATASCO TO SOLVE YOUR CORROSION PROBLEMS. WRITE FOR COMPLETE INFORMATION AND COSTS.

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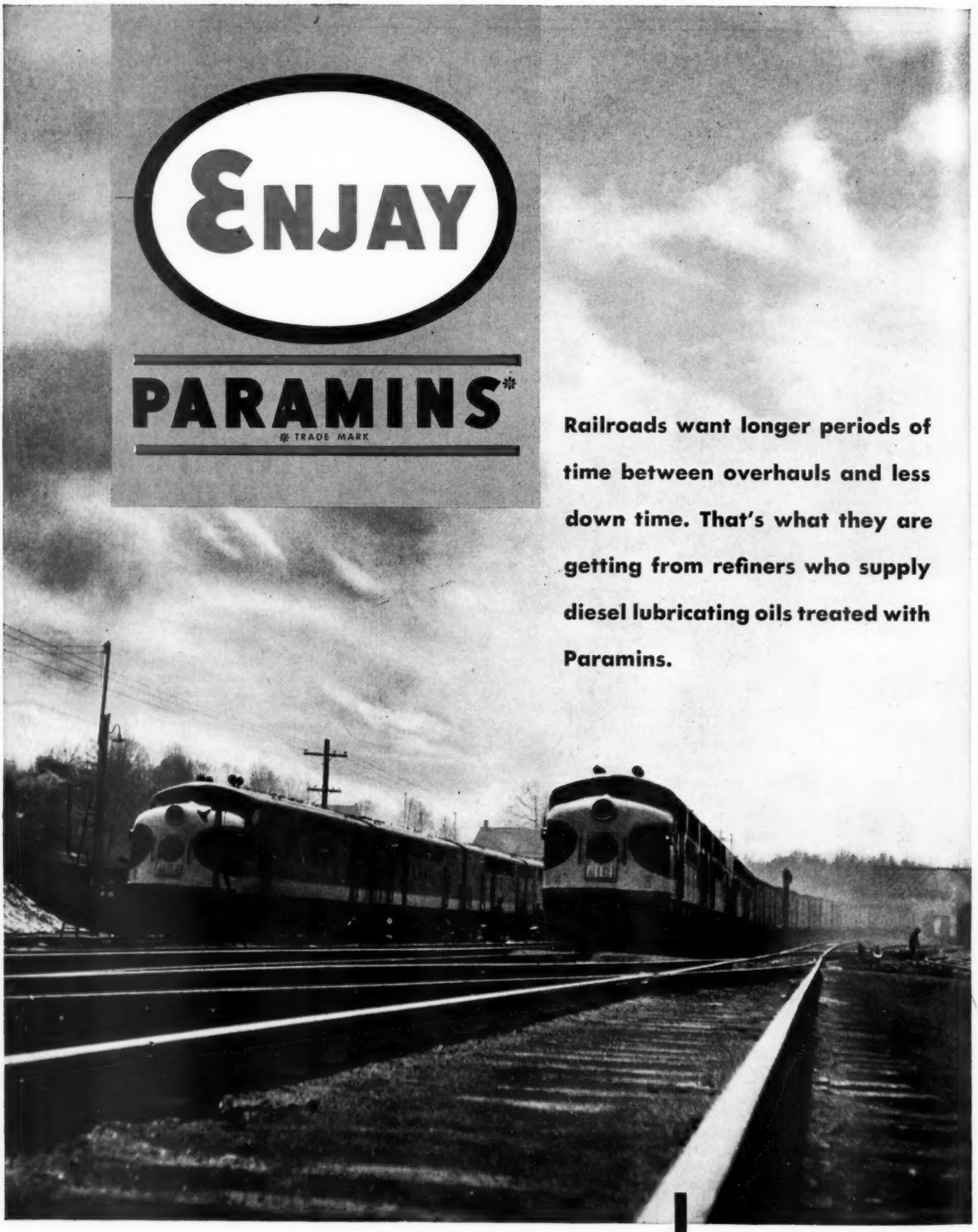
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Personals

John E. Swearingen has been named executive assistant to **J. E. Rouse,** vice president in charge of operations for Stanolind Oil and Gas Co., succeeding **Lewis Finch, Jr.,** who has been transferred to Fort Worth as division engineer. New assistant operating superintendent of the manufacturing department is **G. F. Moore.** Both men are in the Tulsa general office.

Mr. Swearingen joined the company as a project engineer in 1947. He received his B.S. degree in chemical engineering from the University of South Carolina in 1938 and his M.S. degree from Carnegie Institute of Technology in 1939.

Mr. Moore also joined Stanolind in 1947, after 12 years in various engineering capacities with chemical companies. He received his B.S. degree from the University of Delaware in 1933.

Robert Matteson, head of the analytical laboratory at the Richmond Laboratories of California Research Corp., subsidiary of Standard Oil Co. of California, is the new chairman of the San Francisco Engineering Council, an organization of 11 major engineering and technical societies.

* * *

William J. Carthaus, has been made assistant to the president, Deep Rock Oil Corp., and will have headquarters in Tulsa. His duties will include refinery modernization and manufacturing research. A graduate of University of Illinois he did special graduate work at Massachusetts Institute of Technology and was with other oil companies before coming to Deep Rock in 1929 as manager of naphtha and specialty sales. He was made general sales manager in 1938.

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Position Open

QUALIFIED PUMP ENGINEER

With experience in refinery and chemical type pumps.

Must have thorough knowledge of various types of pumps and their application, packing, seal oil systems, materials of construction, and be able to write specifications, select proper equipment and assist in designing installations. Applicant should have about ten years' experience. Location—New England.

BOX 28

Classified Rates

"For Sale," "Wanted to Buy," "Help Wanted," "Business Opportunities," "Miscellaneous" classifications, set in type this size, without border—20 cents a word. Minimum charge, $5.00 per insertion.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Why a Coal Refinery Until Prospects For Oil In Alaska are Fully Appraised?

PROPONENTS FOR ESTABLISHING a commercial synthetic liquid fuel industry in this country, in part at least with taxpayers' money, are now suggesting the Army build a 7000-10,000 bbl. coal-to-oil plant in Alaska, to supply a part of the military fuel requirements there. The Bureau of Mines has estimated $112 and $200 million as the cost, the difference depending on whether the Fischer-Tropsch conversion synthesis or the hydrogenation process is used.

In a statement to a Senate Committee, an Interior Department spokesman dwelt on the coal reserves in Alaska and on the need for Diesel fuel and heating oils there as a combination of circumstances warranting a synthetic fuel industry.

Any proposal now for a synthetic fuel plant in Alaska assumes that the prospects for finding crude production in Alaska are indeed remote, if not entirely non-existent; also that the work on coal synthesis in this country to date has been sufficient to determine what type of full-scale, coal-to-oil plant is practicable to build. Both assumptions are incorrect in the light of the published data available. Concrete programs based upon them are misleading to the public and would cost it a great deal of money.

Geologists for the U.S. Geological Survey and the Navy have done preliminary exploratory work in several areas in Alaska, including the Naval Reserve of 35,000 square miles in northern Alaska. Their published reports would seem to warrant further efforts to learn whether large petroleum accumulations do exist there before going to oil-from-coal plants in this region.

The Survey started its current work in 1944, at the request of military authorities, selecting three large areas that seemed most promising based on earlier reconnaissance work. John C. Reed, reporting for the Survey in 1946, stated that a number of structures or other indications regarded as favorable for the possible accumulation of petroleum were found, which seemed worthy of intensive investigation.

Lieut. Commander W. T. Foran, geologist in charge of exploratory work by the Navy in the Naval Reserve area at about the same time, said the region has all the geologic qualifications demanded of a potential oil setting and he said further; "With its enormous volume of marine sediments, its numerous and conspicuous oil and gas seepages, and remarkable regular structural alignment, it may legitimately be considered the most attractive looking, yet untested petroliferous area in the Western Hemisphere". Some further test work has been done by the Navy but nothing like the amount warranted in view of the vast areas involved.

The public has a great deal at stake in what is done in the national defense program to meet the possible liquid fuel requirements in the northern part of this continent. There has been little incentive to date to establish a commercial petroleum industry in Alaska. However, if oil does exist there in commercial volumes, it can be found and brought into use at less cost than for synthetic fuel plants and likely in part at least through the efforts and investments of the oil companies.

If it is determined that there is no petroleum in Alaska or that its production is not economic, the synthetic fuels development program in this country by that time may have arrived at the point where it can be determined what type of synthetic fuel plant is practicable to build. Coal-to-oil plants installed in the meantime would be costly experiments under most difficult operating conditions.

Stimulus to Improving Means For Refining Heavy Oils

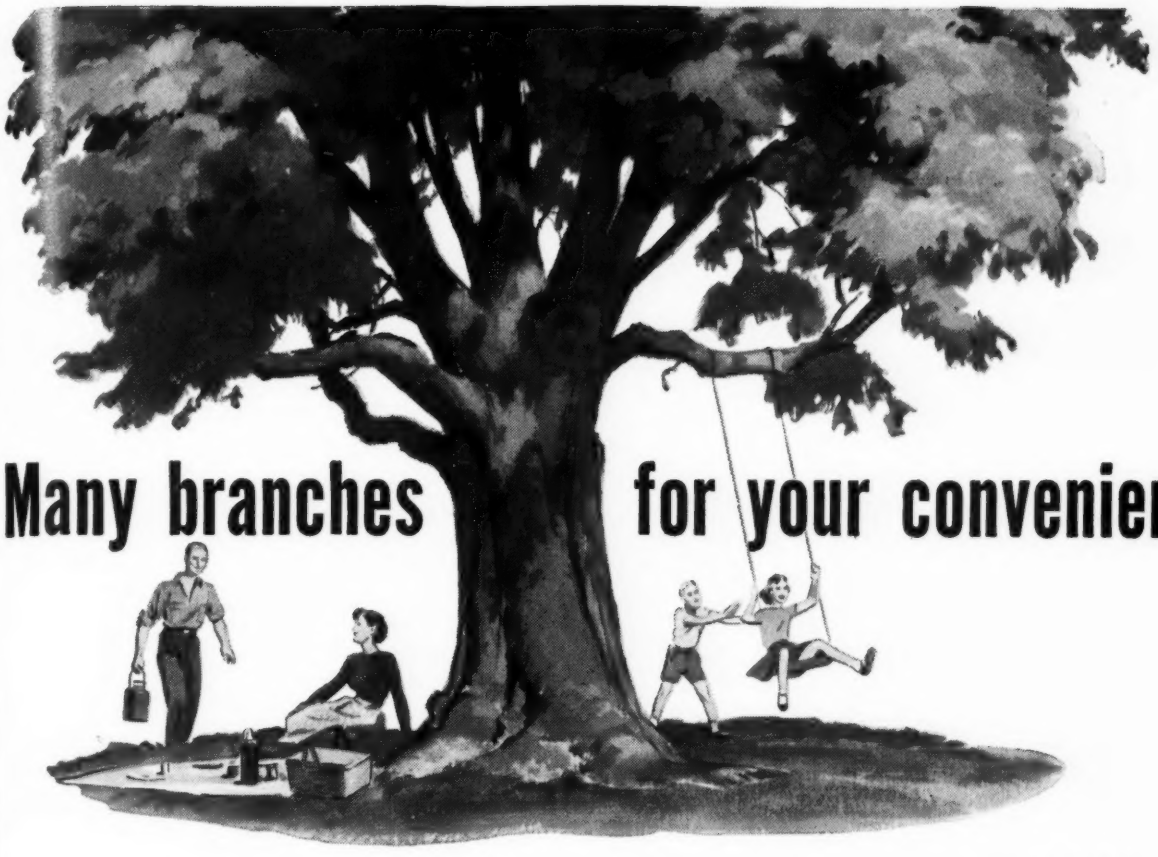
AN IMPORTANT CONTRIBUTING CAUSE of the relative scarcity of distillate products the past few years is the great growth in the use of Diesel fuel by the railroads. The average demand from this source today is placed at 80,000 bbls. a day, far more than the total for all uses 10 years ago. More significant is the estimate of the same authorities, Standard Oil Development Co., that the demand for Diesel fuel from the railroads will increase by 20,000 to 25,000 bbls. a day for each year of the next five years. Thus total demand in 1953 would be 200,000 bbls. a day, equivalent to the total consumption of Diesel fuels from all sources in 1947.

If all railroad duties, passenger, freight and switching, were to be taken over by Diesels, total consumption of Diesel fuel would reach 300,000 bbls. a day. The present 270,000 bbls. daily of fuel oil consumed in oil-fired steam locomotives about equals the volume of Diesel fuel required to power all the railroads if they were completely converted to Diesel. Another authority states the same fact in another way by saying that the final use of Diesel fuel by the railroads would be around 5½% of the total petroleum supply as against a present use of 7½%, due to the lower efficiency when the petroleum is used to fire steam equipment.

Along with the increase in demand for Diesel fuel in coming years from the railroads and other users, demand will continue to grow for other distillate products, for home heating, to supply the kerosene market, and so on. Meeting the total consumer demand for distillate products is likely to become a problem the refiner cannot meet by any amount of juggling of his middle cuts.

Even the likelihood of such a condition seems already to have stimulated further the study of means for converting heavier fractions not only into motor fuels, but also into high grade distillate products; through feed preparation and the use of heavier charge stocks, including liquids, in catalytic cracking.

Through refining technology, the fuel oil the railroads release as they adopt Diesel equipment may be returned to them in the form of a product they can utilize more efficiently than in fueling steam boilers.



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